Plant Science Instrumentation

Delta-T Devices

Eijkelkamp Agrisearch Equipment

UMS measure to know

HOSKIN SCIENTIFIC

SOILMOISTURE

DECAGON DEVICES

ADC BioScientific Ltd.

HOSKIN SCIENTIFIC LTD.

www.hoskin.ca

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ADC BioScientific Ltd.

2 year warranty

AM300

Portable Leaf Area Meter

Non-destructive measurements of whole leaf area and areas of leaf disease

- **Unique image display**
- **High resolution**
- **Battery portable**
- **Non-destructive**
- **Fast and simple operation**
- **Integral data and image storage**
- **Download image to a PC**

ADC BioScientific is established as one of the world's leading developers and manufacturers of leaf area meters that are easy to use, accurate and reliable in harsh field conditions. We are now pleased to introduce our third generation of Portable Leaf Area Meters; the AM300.

The AM300 utilises the latest in scanner and electronics technology to set new standards in resolution, versatility and extended portability.

Truly field portable

The ADC AM300 Portable Leaf Area Meter is a compact, user-friendly, field portable instrument for the accurate non-destructive measurement of leaf area and associated parameters.

The AM300 consists of a high resolution scanner and scanboard with integral data and image storage. A multi-position carrying handle is provided for ease of use and increased portability. Measurements of leaves can be made on the scanboard plate or on an independent plain surface.

The AM300 features the latest in high speed scanner sensor technology, enabling measurements to be made faster and easier than ever. There is no need to precisely position leaves on the scan surface.

Utilising the latest in low power consumption electronics means that over 3,000 measurements can be made between recharging of the batteries.

Image download to a PC

The large scrolling display screen offers a real time image display of the scanned leaf together with measured leaf area parameters. By viewing this image, the user can be assured that an accurate and complete measurement of the leaf has been made. Measurements may be presented in mm, cm or inches.

The display orientation facility allows the AM300 to be used in either the vertical or horizontal plane. Operation is by user-friendly, menu driven software.

The AM300 is the first portable area meter that displays, stores and downloads the leaf image to a PC. Images are easily downloaded, in either bmp or tif formats, to commercially available image analysis programs.

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Measurement of diseased leaf area

The highly versatile AM300 has been especially developed to enable diseased leaf area determinations to be made on intact plants in the field. Once again the image display provides the user with assurance that only the diseased tissue is being measured.

Long leaves are easily measured, non-destructively, on an independent scan surface. The image screen will scroll to display and save the whole of the leaf area.

Large leaves, which are wider than the width of the scanner, may also be measured, non-destructively, on an independent scan surface. The use of a scan board twice the width of the scanner will allow measurements to be made and then automatically accumulated to present a total leaf area with the leaf still intact.

The enhanced resolution (0.065mm^2) of the AM300 allows even the smallest leaves, including arabidopsis, to be accurately measured. The AM300 can also be used for root and rhizomorph area determinations.

Integral data storage

Measurements, together with leaf images, may be automatically recorded on the large internal memory, capable of storing over 2,000 sets of data in a number of data files. Time and date of measurements are also automatically stored by the AM300.

The AM300 will measure area, accumulated area, average area, maximum width, maximum length and perimeter.

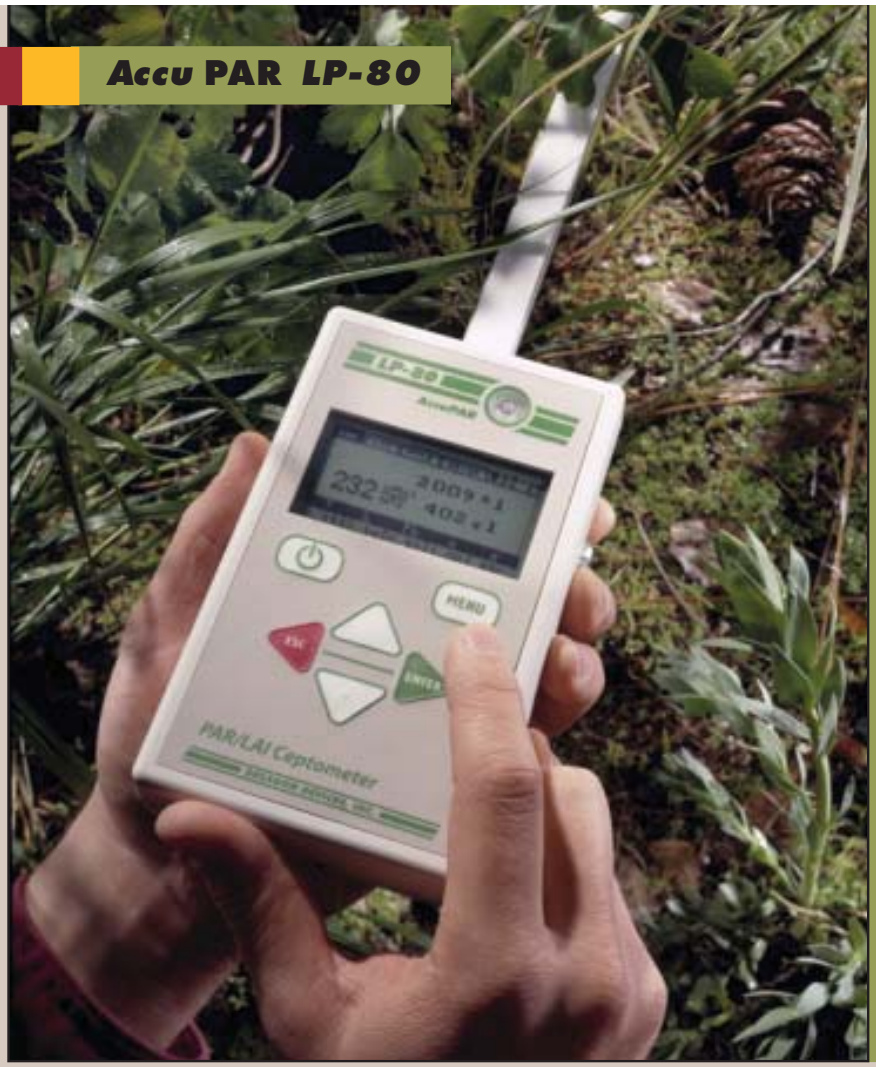
Internal battery back-up gives increased security to stored data.

Measurements and scanned images can be reviewed on the display, transferred to a printer or downloaded to a personal computer. The AM300 is supplied complete with an interface cable.

Technical Specification

Measured parameters:	Leaf area, length, width, perimeter, average area and accumulated area
Units of measurement:	User selectable: mm, cm, inches
Scanner:	Contact image sensor array with integral LED lamp
Maximum measurement width:	100mm
Precision/repeatability:	1% Linear, +/- 2% Area, +/- 5% Perimeter
Resolution:	0.065mm^2
Memory:	256K bytes RAM, 2,000 data sets
Display:	64 x 240 pixel graphic LCD
Battery:	Nickel metal hydride 1.2Ah
Battery charger:	Built in fast charger; can use supplied mains adapter or 12V car battery. Indicators for charge status.
Computer interface:	RS232C with baud rates from 300 to 57600, xon/xoff or CTS handshake.
Printer interface:	Centronics™ parallel or RS232
Dimensions:	275mm x 250mm x 30mm
Weight:	1.8kg

Accu PAR LP-80



LEAF AREA INDEX & PHOTOSYNTHETICALLY ACTIVE RADIATION

- With the new LP-80, you get instant real-time PAR measurements as soon as you turn it on, and your LAI data is updated with each PAR measurement.
- Intuitive 6-key menu-driven interface
- Included external PAR sensor for simultaneous above and below-canopy PAR measurement
- Large memory capacity
- Low power consumption/4AA alkaline battery-powered (2 years)

Long-battery life, instant real-time PAR and LAI measurements, plus free external radiation sensor.

THE LP-80 IS DESIGNED for ease of use—helping you to minimize setup time and begin measuring as soon as possible. It only has 4 menus: PAR/LAI sampling, unattended logging, file access, and setup, and its intuitive 6-key interface allows you to navigate inside these menus with up and down arrow keys, and move from menu to menu with one button push.

INSTANT REAL-TIME PAR/LAI SAMPLING

As soon as you turn the LP-80 on, you're measuring PAR in the PAR sampling mode. Real-time PAR values are displayed on screen, and can be stored with the press of a button. Simply take one PAR reading above the canopy and one below it, and an LAI calculation is displayed. With each subsequent measurement, this value is updated and displayed on the screen.

UNATTENDED LOGGING

The unattended PAR sampling mode lets you program the instrument to make and store measurements at intervals from once a minute to once an hour.

FREE EXTERNAL PAR SENSOR

The LP-80 is shipped to you with an external PAR sensor. This allows you to make simultaneous above and below-canopy PAR measurements with one button push. You can also re-normalize the LP-80's probe sensors as often as you want by calibrating it against the external sensor.

USER-CALIBRATED PROBE

The external PAR sensor only needs to be calibrated once every 1–2 years, so this allows you to keep your probe calibrated and accurate while keeping costs low.

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ACCUPAR ACCESSORIES INCUDED WITH YOUR PURCHASE:

1. EXTERNAL PAR SENSOR
2 meters long with connector for direct connection to the ceptometer's external port. Calibrated to provide an output of about 0.1 mV perμmol m-2 s-1 (calibration label provided). 1/4 x 20 threaded insert for mounting; domed top. Calibrated to sunlight or electric lamps.

2. NON-MAGNETIC SCREWDRIVER.

3. RS-232 CABLE
— for interfacing between your computer and the AccuPAR.

4. LP-80 USER'S MANUAL

5. CARRYING CASE
Polyethylene hardened case. foam cutouts allow the instrument and its accessories to safely be stored inside. 3.6kg, 11.8cm x 24cm x 109cm.

HOW ACCUPAR WORKS

THE ACCUPAR MODEL LP-80 is a linear PAR ceptometer consisting of an integrated probe and microcontroller. The probe is 86.5cm long and contains 80 sensors that are sensitive to the PAR waveband. The microcontroller interprets the PAR signals coming from the probe, allowing you to read PAR. It also calculates LAI of your samples instantly with each PAR measurement you take, using the intercepted and available PAR and other variables.

NEW CEPTOMETER FEATURES

- With the new LP-80, you get instant real-time PAR measurements as soon as you turn it on, and your LAI data is updated with each PAR measurement.
- Intuitive 6-key menu-driven interface
- Included external PAR sensor for simultaneous above and below-canopy PAR measurement
- Large memory capacity
- Low power consumption/4AA alkaline battery-powered (2 years)

SPECIFICATIONS

Operating environment: 0° to 50°C (32°-122°F) 100% relative humidity.

Probe length: 86.5cm.

Number of sensors: 80.

Overall length: 102 cm (40.25in).

Probe cross-Section:
1.9cm x 0.95cm (0.75 x 0.375in).

Microcontroller dimensions:
15.8 x 9.5 x 3.3cm (6.2 x 3.75 x 1.3 in.)

PAR range:0 to >2,500μmol $m^{-2}s^{-1}$.

Resolution: 1μmol $m^{-2}s^{-1}$.

Minimum spatial resolution: 1cm.

Data storage capacity: 1MB RAM.

Unattended logging interval:
User selectable, between 1 and 60 minutes.

Instrument weight:
1.21kg (2.7lbs).

Data retrieval: Direct via RS-232.

Keypad: 6-Key menu-driven.

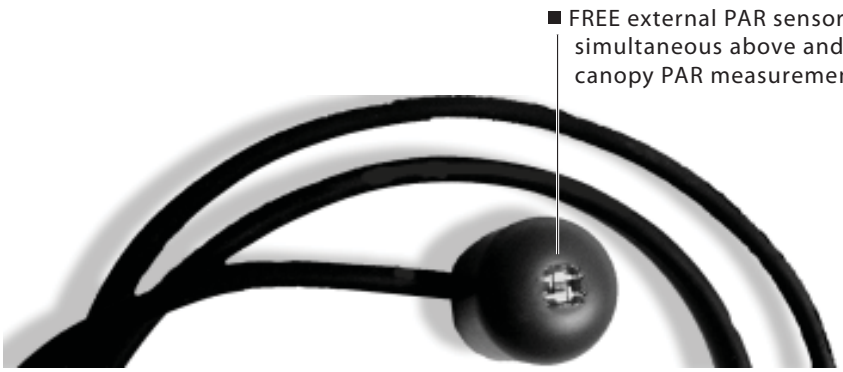
Clock: 24-hour ±1 minute per month.

Interface cable: RS-232 cable.

Power: Four AA Alkaline cells.

External PAR sensor connector:
Locking 3-pin sealed circular connector.

Accu PAR LP-80



Delta-T Devices – Data Sheet

HemiView

Canopy Analysis System type HEMIv8

Hemispherical image analysis for forest canopies

HemiView provides detai led and authoritative analysis of hemispherical photographs

- Calculates canopy structure parameters and solar radiation indices
- Predicts radiation levels beneath canopy
- Ideal for tall irregular canopies

Introduction

Hemispherical photography is ideal for the analysis of plant canopies, especially tall, irregular canopies, such as forests. Typically photographs are taken in uniform sky conditions, looking upwards from beneath the plant canopy using a 180° fisheye lens. A self-levelling camera mount ensures the camera is held horizontally.

HemiView uses the hemispherical image together with lens and site data to produce measures of canopy structure e.g. gap fraction and Leaf Area Index (LAI). Combining this information with a solar radiation model, HemiView can predict radiation levels above and below the canopy, and hence direct, indirect (diffuse) and global site factors.

By plotting the solar path over the canopy and allowing for the size of the solar disc, HemiView also calculates the occurrence of sunflecks and associated solar irradiance on any chosen day of the year. Results are stored in Excel compatible worksheets.

Digital SLR camera in the SLM8 Self-levelling Mount

HemiView hardware

The HemiView Canopy Analysis System consists of HemiView software, a digital SLR camera with fisheye lens, a self-levelling camera mount and a range of accessories. The camera provides excellent resolution (15.1 megapixels) and its 2GB memory card can store ~350 full resolution .jpg images. The light weight self-levelling mount greatly simplifies the process of obtaining correctly oriented photographs and is essential for obtaining images high up in forest canopies. It provides LED markers fired by the flash gun that automatically places north / south orientation markers into each image taken.

Sunshine Sensor type BF3

The Sunshine Sensor can be used to monitor the direct and diffuse components of PAR over extended periods. In detailed studies such data can be used to derive transmittivity and diffuse proportion values, as required for the solar model used in HemiView.

HemiView specifications

Image file types	BMP, JPG, TIF, Photo CD.
Image resolution	Minimum practical 512 x 512 Maximum limited by hardware resources.
Lens distortion	Can be specified as a polynomial relating zenith angle and radial distance.
Direct light model	Simple atmospheric transmission, with user defined settings.
Diffuse light model	Uniform or Standard overcast sky.
Data output	Excel compatible spreadsheet built-in.

Outputs

Sky Geometry	Centroid, solid angle and pixel count for each sky sector.
Gap Fraction	Proportion of visible sky by sector.
Leaf Area Index	By sky sector or overall value.
Solar Radiation	Direct and diffuse, above and below the canopy, in energy or molar units.
Site Factors	Direct, indirect (diffuse), global.
Time series and Sunflecks	Visibility of the solar disc (penumbral effects) and solar irradiance on chosen days, sampled at user-defined intervals or summarised as a sunfleck sequence.
Optional cosine correction	For any orientation of intercepting surface.
Overall values	Most outputs can be tabulated by sky sector, or aggregated into a single overall whole sky or annual value.

Features

Interactive graphical alignment tool	Precise registration of images with the hemispherical co-ordinate system. Compensates for magnetic declination.
Responsive image classification	Threshold intensity di scriminates visible and obstructed pixels. The classified image view is updated in real-time.
Multiple and split views on any image	Classified and colour / grey scale views, or separate sections of a large image can be viewed side by side.
Negative images	Photographic negatives can be viewed and analysed as positives.
User-defined number of diffuse sky regions	Enables use of custom ranges of zenith and azimuth angle.
Leaf Area of a Single Tree	Excel spreadsheet provided with instructions for calculating single tree LAI using HemiView outputs
Analysis of partial images	Unwanted parts of images can be ignored by the analysis.
Configurable for site, lens, solar model	User-defined site, lens and solar model characteristics can be applied to any image by selecting from a list.
Pre-defined lens characteristics	Lens equations are provided for current and previous lens types supplied by ΔT.
Results output to Excel compatible workbook	Additional calculations can be performed using standard spreadsheet formulae. Alternatively, workbooks can be saved for further analysis using Excel. Results can be appended to existing workbooks.
User-defined output configurations	The user can define multiple custom output configurations which can be applied to different images.

Ordering information

HemiView system

HemiView Canopy System type HEMIv8 Includes HemiView Software, SLM8 self levelling camera mount, DCM8 Digital SLR camera with flash unit, 2GB memory card, rechargeable battery & charger, SCL8 fisheye l ens and MPD1 telescopic monopod

Individual items

HemiView Software type HMV1 software and manual

Self-levelling Camera Mount type SLM8 for DCM8 camera and fibre optic flash transfer assembly

Digital SLR camera type DCM8 full frame SLR camera with 15.1 megapixel CMOS sensor, flash unit, 2GB memory card, rechargeable battery and charge r. Supplied without lens.

Fisheye Lens type SCL8 for DCM8 camera

Telescopic Monopod type MPD1 for raising SLM8, extendable 0.69 to 1.66m

Optional items

Telescopic Tripod type HMV-TD2, holds SLM8

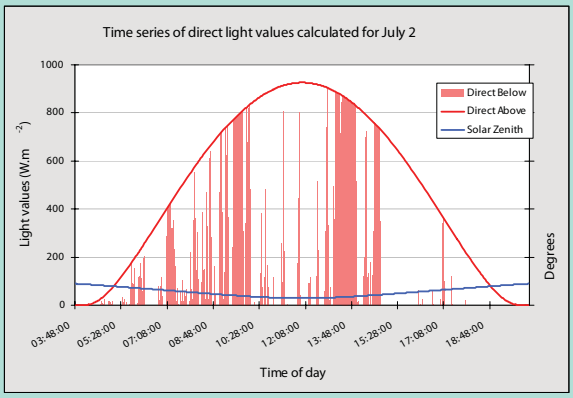
Waterproof Case type HEMI-CC1 protective, impact resistant case to hold DCM8 camera, SCL8 fisheye lens and SLM8 camera mount.

For spares, please enquire

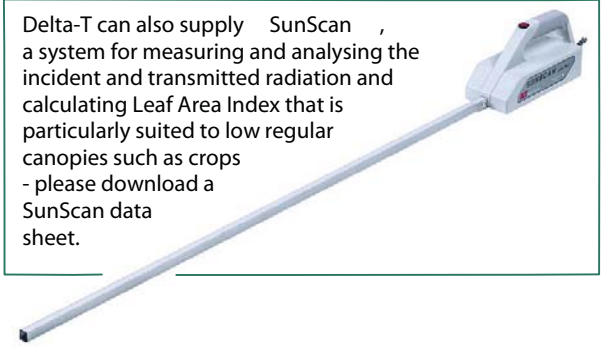
Camera upgrades

Older versions of HemiView will benefit from upgrade to the new high resolution DCM8 digital SLR camera, but note that changing the camera will also require upgrading the self-levelling mount and fisheye lens.

Sample time-series calculation of light levels



Delta-T can also supply SunScan , a system for measuring and analysing the incident and transmitted radiation and calculating Leaf Area Index that is particularly suited to low regular canopies such as crops - please download a SunScan data sheet.



Leaf Wetness
Dielectric Sensor

INNOVATIVE and easy-to-use, the new Dielectric Leaf Wetness Sensor enables accurate and affordable leaf wetness monitoring. Many fungal and bacterial diseases affect plants only when moisture is present on the leaf surface. The Leaf Wetness Sensor determines the presence and duration of wetness on a leaf's surface, enabling researchers and producers to forecast disease and protect plant canopies.

How It Works

The Leaf Wetness Sensor approximates the thermal mass and radiative properties of leaves to closely mimic the wetness state of a real leaf. The way it works is simple: if the canopy is wet, the sensor is wet; if the canopy is dry, the sensor is dry. The Leaf Wetness Sensor measures the dielectric constant of the top of the sensor. The dielectric constants of water (80) and ice (5) are higher than air (1), so the sensor can determine the presence or absence of wetness using this method. Measurements can be logged at user-defined intervals to determine the duration of wetness on the canopy.

Sensor Benefits

Because the Leaf Wetness Sensor measures the dielectric constant, moisture does not need to bridge electrical traces for the sensor to detect moisture; the presence of water or ice anywhere on the sensor surface will be detected. Unlike common resistance-based sensors, it requires no painting or user calibration, and it can detect ice presence. The low power requirement and long battery life (2+ years with Em50 Datalogger) enable effective long-term leaf wetness monitoring. ■

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Dielectric Leaf Wetness Sensor

- Forecast plant disease
- Modeling for blight
- Canopy treatment scheduling
- Imitates characteristics of a real leaf
- Requires no painting or user calibration
- Can detect ice on the "leaf" surface
- Low power
- High resolution

Leaf Wetness Sensor Specifications

Measurement time 10 ms

Power 2.5VDC @ 2mA to 5VDC @ 7mA

Output 250 to 1500 mV

Operating Environment

-10°C to 60°C

Expected Lifetime

2+ years continuous use

Probe Dimensions

11.2cm x 5.8cm x 0.075cm

Cable Length

5m standard,
extension cables available

Connector type 3.5mm plug

Datalogger Compatibility

(not exclusive)

Decagon Em5b, Em50, Em50R

Campbell Scientific CR10, 10X, 21X,

23X, 1000, 3000, 5000

Benefits

- No user manipulation or painting required
- High resolution detects trace amounts of water or ice on the sensor surface
- No calibration necessary; factory calibration set at standard wetness threshold
- Low power requirements enable long-term leaf wetness monitoring

Applications

- Disease forecasting and modeling
- Ecological and Agricultural Research

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Munsell Plant Colour Charts

Munsell Plant Tissue Color Charts provide a handy color reference. They've been used throughout the world for years to help scientist research growth rates, nutrient deficiencies, diseases and other plant processes.

Small, protective binder makes it ideal for field use.

Features:

•17 hue-based color charts including (2.5R, 5R, 10R, 2.5YR, 5YR, 7.5YR, 2.5Y, 5Y, 2.5GY, 5GY, 7.5GY, 2.5G, 5G, 7.5G, 5BG, 2.5B and 5RP)

•320 matte color chips, permanently mounted

•Easy view mask

•Vinyl protective binder

** Helpful hint...*

replace your charts every two (2) years to ensure accurate color comparison.

MQ-100, 200, & 300 Series

Quantum Meter

Measures instantaneous Photosynthetic Photon Flux.

Description

A quantum refers to the amount of energy carried by a photon. Quantum meters approximate the quantity of photons between 400 and 700 nanometers. Photosynthesis is largely driven by the number of photons between these wavelengths so this radiation is called the Photosynthetic Photon Flux (PPF) and is measured in µmol m^{-2} s^{-1} (micromols of photons per meters squared per second).

Our meters include data recording capability and sun and electric calibration with each meter.

Each meter can store up to 99 manually recorded measurements. In automatic mode, measurements are made every 30 seconds and averages are stored every 30 minutes. Daily totals are also calculated and the past 99 days are recorded. The AC-100 communication cable must be purchased to download data to a PC.

These meters feature our innovative blue lens for improved spectral response along with our cosine-corrected head, self-cleaning characteristics, and long-term stability.

Ordering Information

All products can be ordered at www.apogeeinstruments.com

For technical information contact techsupport@apogee-inst.com

(SMPL) 99 Sample Measurements	(LOG) 99 Log Measurements	(LOG) 99 Daily Total Measurements
Viewable on meter LCD & downloadable		Downloadable Only

Recommended Accessories

AL-100 A leveling plate used to keep meters with separate sensor level. (MQ-200)

AL-210 Leveling plate and mounting base for meters with integral sensor.

AC-100 Communication cable is required for data download to a computer.

Specifications

Memory

- 99 manually stored data points
- Automatically store 99 consecutive 30 minute averages
- 99 daily averages

Input Power

- Standard 3 V coin cell battery

Mass

- MQ-100: 150 g
- MQ-200: 180 g
- MQ-301: 380 g
- MQ-303, MQ-306: 300 g

Operating Environment

- 0 to 50º C
- Less than 90% non-condensing relative humidity up to 30º C
- Less than 70% relative humidity from 30 to 50º C

Cable (MQ-200 & 300 Series)

- 2 meters of twisted-pair wire
- Shielded w/ Santoprene casing
- Longer cable lengths are available in multiples of 5 meters

Measurement Range

- 0 to 2999 µmol m

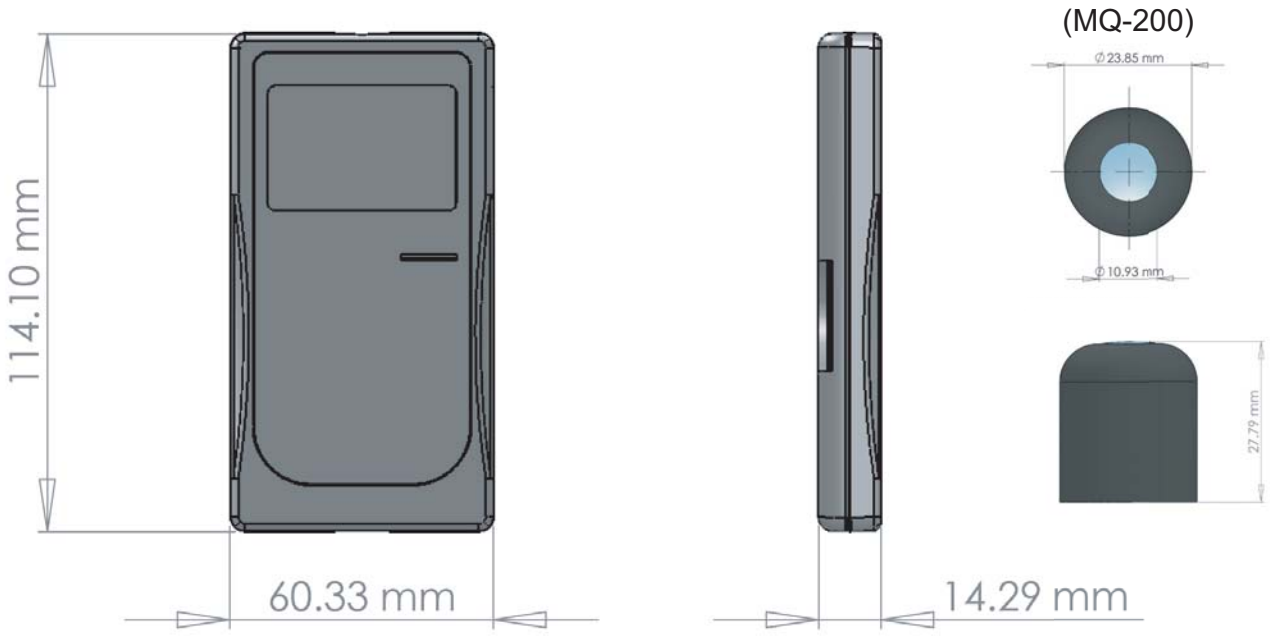
Display

- 4.5 cm width by 2.8 cm height

Warranty

- 1 year against defects in materials and workmanship

Measurements



Delta-T Devices - Light Sensors

Three types of sealed photodiode sensors are now available:

- A photosynthetically active radiation PAR sensor (the QS2)
- A solar energy flux sensor (the ES2)
- A range of three UV sensors (the UV3pA, UV3pB, & UV3pAB)

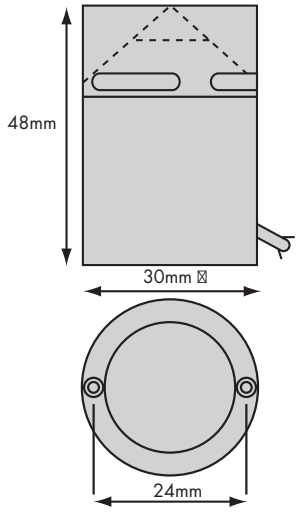
These sensors replace the previous Delta-T models offered.

- **mV outputs pre-set to identical standard values for each sensor type**
- **Self-cleaning, stay-dry diffuser with water drainage slots**
- **Good cosine response with infinity error correction ring**
- **Quality photodiodes – high stability with low temperature coefficient**
- **Hard-anodised aluminium body**
- **Lower purchase and recalibration cost**

The UV sensors are fitted with a transimpedance amplifier operating from a single rail power supply.

All sensors can be provided with an optional aluminium mounting plate (type SRLF1) which includes a bubble level, and levelling adjusters.Alternatively a levelling plate is available for standard Delta-T weather station masts (takes 2 ES2 or QS2 or 1 E/QS2 and 1 UV3p).

Type	ES2	QS2	UV3pA	UV3pB	UV3pAB
Spectral region	Solar Energy	PAR	UV "A"	UV "B"	UV "AB"
Spectral response	400–1050 nm	400–700 nm			
Peak wavelength			373 ±2nm	313 ±2nm	360 ±5nm
Bandwidth			31 ±2nm	26 ±2nm	72 ±5nm
Relative spectral response	Standard graph for all sensors		Individual spectral response for each sensor		
Ouput sensitivity	10 mV per kW m^{-2} of total solar radiation	10 mV per mmol m^{-2} s^{-1}	1 mV per W m^{-2}		
Accuracy (error) at 20°C traceable to NPL & BSI stds	±3%*	±5%	±7.5%		
Measuring range	0-2 kW.m^{-2}	0-3 mmol m^{-2} s	0-150 W m^{-2}	0-150 W m^{-2}	0-200 W m^{-2}
Cosine corrected	within ±5% up to 70° incidence		within ±5% up to 70° incidence		
Voltage supply	n/a		7-15 V dc (<12mA)		
Size (mm)	48 high x 30 dia		48 high x 50 dia (base)		
	* Calibrated under a spectro-radiometrically controlled Lambertian Source.				



ES2 + QS2
(UV3p not shown)

Further Information

Data sheets and in some cases technical notes and academic papers, are available on all the instruments mentioned in this Product News brochure. If you have any questions about the instruments or their applications, please let us know and we'll do our best to help.

Technical Support

We have recently re-organised our technical support function. If you require technical support on any of our products please contact us (preferably by e-mail: tech.support@delta-t.co.uk). You will immediately be issued with a Technical Support reference number, and we will then endeavour to answer your query as rapidly as possible.

Overseas Representation

Delta-T has an extensive network of representatives to serve customers outside the UK. In these countries, all sales and technical enquiries should be directed to our representatives; details are available.

Amplified Quantum Sensors

SQ-200 series: 2.5V or 5V
(sun or elec calibration)

For orders out of the USA add 10% to the list price

US Patent No. D519,860
Additional patents anticipated

- Sensors available with 2.5 or 5.0 V output
- Designed for use with lower resolution dataloggers
- Self-cleaning domed head
- Potted solid for use in humid environments

Specifications

		SQ-210 series (sunlight)	SQ-220 series (electric)
Calibration		Natural sunlight	Electric lamps (8% difference)
Absolute accuracy		± 5%	± 5%
Uniformity		± 3%	± 3%
Repeatability		± 1%	± 1%
Application		Measuring Photosynthetic Photon Flux	
2.5 V option	**Output**	0 to 2.5 V (2.0 V = full sunlight 2,000 µmol m^{-2} s^{-1})	
	Input power	2.5 to 5.5 VDC	
	Sensitivity	Custom calibrated to exactly 1.00 µmol m^{-2} s^{-1} / mV	
5.0 V option	**Output**	0 to 5 V (4.0 V = full sunlight 2,000 µmol m^{-2} s^{-1})	
	Input power	5 to 5.5 VDC	
	Sensitivity	Custom calibrated to exactly 0.50 µmol m^{-2} s^{-1} / mV	
Current draw		285 µA	
Operating environment		- 40 to 55 °C; 0 to 100% relative humidity. Designed for continuous outdoor use. Can be submerged under water (with or without mounting screw).	
Materials		Anodized aluminum with acrylic lens	
Cable		3 m of shielded, twisted-pair wire with Santoprene casing, ending in pigtail leads. Additional cable is extra	
Dimensions		2.4 cm diameter x 2.75 cm high	
Mass		70 g (with 3 m lead wire)	

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SunScan Canopy Analysis System

SunScan Probe Specifications

Active Area
1 m x 13 mm wide; sensor spacing 15.6 mm
Spectral response
400 - 700 nm (PAR)
Measurement time
120 ms
Maximum reading
2500 µmol.m^{-2}.s^{-1}
Resolution
0.3 µmol.m^{-2}.s^{-1}
Linearity
Better than 1%
Accuracy
±10%
Analogue output
1 mV per µmol.m^{-2}.s^{-1}
Serial interface
RS-232, 9 pin female 'D' connector
Environmental
IP65, 0 - 60° C working temp
Size (mm) & Weight
1,300 (l) x 100 (w) x 130 (h), 1.7kg
Power
Four AA Alkaline cells (lifetime up to 1 year)

Rugged PDA type RPDA1

Screen
¼ VGA sunlight readable
Operating system
Windows Mobile 6
Display options
a) LAI
b) PAR average
c) ALL individual sensor readings
Environmental
IP67, -30 °C to 60 °C, 1.2 m drop test
Power
Rechargeable battery, 12h continuous use
Memory
>100 MB available
Size & Weight
165 mm x 95 mm x 45 mm, 450g

- **Measures incident and transmitted PAR in plant canopies**
- **Direct display of Leaf Area Index (LAI)**
- **Unique BF3 Sunshine Sensor reference measures Direct and Diffuse components of incident light**
- **Usable in cloudy, clear and changeable conditions**
- **Portable, weatherproof and battery powered**

SunScan Probe - SS1

The probe has an array of 64 PAR sensors embedded in a 1 meter long probe, and is connected via an RS-232 cable to a handheld PDA. As a reading is taken, all the sensors are scanned and the measurements are transmitted to the PDA.

The average light level along the probe is calculated, and all of the individual sensor readings are available if required for detailed PAR mapping. An operating button on the probe handle enables successive readings to be taken quickly and simply on demand. Alternatively, unattended logging can be conducted under program control from the PDA. Readings are in units of PAR quantum flux (µmol m^{-2} s^{-1}) and units of LAI (m^2.m^{-2}).

Sunshine Sensor BF3

SunScan features a unique optional reference sensor which measures the direct and diffuse components of light simultaneously above the canopy.

The special shading pattern of the dome is matched to an array of photodiodes in such a way that at least one photodiode always sees an unobstructed solar disc and at least one is always in full shadow. The BF3 uses this information to calculate whether the sun is shining and to measure the direct and diffuse components of solar radiation, avoiding the need for the shade ring adjustments required with conventional diffuse light sensors (levelling is the only adjustment required).

Data Analysis And Storage

The RPDA1 is an exceptionally robust handheld PDA which collects and analyses readings from the SunScan Probe. Raw readings, and derived functions such as LAI, can be displayed, reviewed and stored in the field by the SunData Software; groups of readings can be averaged if required.

Readings are stored in the internal memory which holds >1 million readings, or in widely available CompactFlash cards which provide removable data storage. Collected data can be transferred easily to a PC.

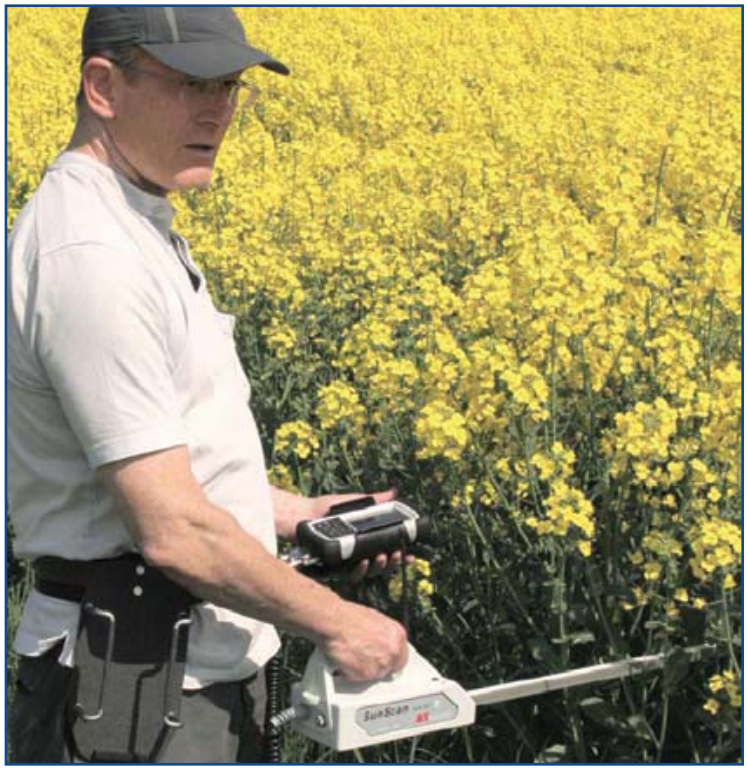
The SunData Software can automatically take readings and averages from the SunScan Probe, at user-defined intervals from 1 second to 24 hours. This can be used for example to obtain diurnal readings of canopy light interception at a particular location.

DYNAMAX

HOSKIN SCIENTIFIC

SunScan Features

System Type	Features and Advantages
SunScan Complete Plus System type SS1-COM. This is the complete package of SunScan items, including SunScan Probe, SunData Software, Rugged RPDA and case, Sunshine Sensor type BF3, tripod and carrying case	The Recommended Plus System provides a powerful canopy analysis tool. It can calculate instant estimates of LAI, measure PAR interception using spot readings or with unattended logging and measure sunflecks. A major advantage for field use is that the BF3 Sunshine Sensor needs minimal adjustment during use.
SunScan Standard System type SS1-ENTRY. The Standard System comprises the SunScan Probe, SunData Software and the Data Collection Terminal	The Standard System is able to make the full range of SunScan measurements, including LAI. However, as the SunScan Probe has to be used as its own above canopy reference, it can only be used in steady light conditions: blue sky or evenly overcast.



BF3 Specifications

Output sensitivity total & diffuse
1 mV / µmol.m^{-2}.s^{-1} PAR cosine corrected
Accuracy } ± 10 µmol.m^{-2}.s^{-1}
Total ± 12%
Diffuse ± 15%
Temperature range
-20 to + 50 °C with alkaline batteries
Range
0 - 2500 µmol.m^{-2}.s^{-1} (total & diffuse)
Spectral response
PAR (400 - 700 nm)
Power
4 x AA Alkaline cells (lifetime up to 1 year)
Input voltage
5 - 15 V DC (powered from SunScan)
Size and weight
4.7" x 4.8" x 3.7" (120 mm x 122 mm x 95 mm), 1.2 lb. (556 g)

Ordering Information for BF3

BF3 Sunshine Sensor. For simultaneous output of total PAR, diffuse PAR, and Sunshine Status. Including user manual and . Cables separate.
BF3H Sunshine Sensor with a built-in thermostatically controlled heater including heater cable for connecting to power supply
BF3-M Cross arm (1 meter) with mounting bracket type BF3\M. Suitable for mounting Sunshine Sensor type BF3 to weather station mast
BF3-SP Sunshine Sensor spares kit suitable for 2 year continuous operation
BFDL-05 Logger cable for Sunshine Sensor (5 m)
BFXL10 Connecting cable (10 m length). Cable with connectors suitable for Sunshine Sensor BF3.

Delta-T Devices

Sunshine Sensor type BF3

- **Measures Global (Total) and Diffuse radiation**
- **Measures Sunshine duration**
- **No routine adjustment or polar alignment**
- **Works at any latitude**
- **No moving parts, no shade rings, and no motorised tracking needed**
- **Outputs can be set to Energy ($W.m^{-2}$), PAR ($\mu mol.m^{-2}.s^{-1}$), or Lux**

The BF3 Sunshine Sensor measures Global (Total) and Diffuse radiation, and sunshine duration. It's easy to use and needs no routine adjustment or polar alignment

Unique design

The Sunshine Sensor is a patented design*. It uses an array of photodiodes with a unique computer-generated shading pattern to measure incident solar radiation. A microprocessor calculates the Global and Diffuse components of the radiation and determines the sunshine state.

Outputs

Two analogue voltage outputs are provided for the Global and Diffuse radiation. The sunshine state is represented by a digital output (either logic level, or contact closure). The three outputs can be connected to appropriate channels on data loggers e.g. the Delta-T logger type DL2e, or other loggers commonly used for environmental monitoring.

** The Sunshine Sensor is protected by patents EP 1012633 & US 6417500*

Applications

Meteorology

- **Solar radiation studies**
- **Sunshine duration**

Architecture and building design

- **Building energy management systems**
- **Heat balance and natural light studies**

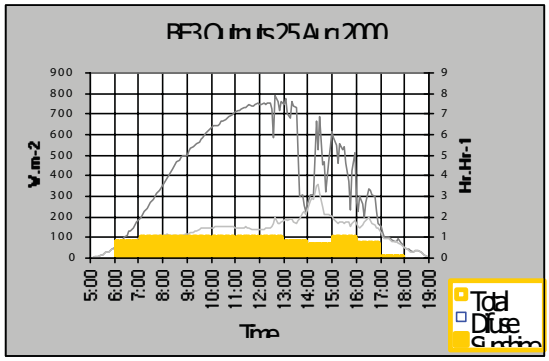
Agronomy & plant science

- **PAR measurement**
- **Canopy analysis & modelling**

Meteorology

The BF3 sensor can be used as an additional sensor with a conventional Met Station. The weather station logger is used to record Global (Total) and Diffuse radiation and the sunshine state (or duration), on three additional channels.

Power for the sensor comes from its internal alkaline batteries or alternatively from the weather station logger battery. Typically the data will be used for Global and Diffuse radiation, and the sunshine hours during the day (see chart opposite). Direct beam radiation is calculated from Total minus Diffuse. Radiation output units can be preset to energy, or PAR, or illuminance.



Specifications

BF3 Accuracy and Resolution

The BF3 is intended for use outdoors in natural daylight, with an unobstructed view of the horizon. Significant errors may be produced by artificial light, or if the BF3 is shaded from direct sunlight by buildings, or if there are strong reflections, from windows, for example.

The following accuracy figures give 95% confidence limits, i.e. 95% of individual readings will be within the stated limits under normal climatic conditions.

	Output setting		
	PAR	Energy	Illuminance
Units	**$\mu mol.m^{-2}.s^{-1}$**	**$W.m^{-2}$**	**klux**
Accuracy: Total rad'n	±12% of reading, ±10	±12%, ±5	±12%, ±0.60
Diff. rad'n	±15%, ±10	±15%, ±20	±15%, ±0.60
Resolution	0.6	0.3	0.060
Range	0-2500	0-1250	0-200
Output sensitivity	1mV = 1 $\mu mol.m^{-2}.s^{-1}$	1mV = 0.5 $W.m^{-2}$	1mV = 0.100 klux
Output	0-2500 mV	0-2500 mV	0-2000 mV

Other specifications

Accuracy: Sun hours	±10% w.r.t. WMO definition
Accuracy: Cosine Correction	±10% of incoming radiation over 0-90° Zenith angle
Accuracy: Azimuthal	±5% over 360° rotation
Temperature coeff't	±0.15% / °C typ. (no thermostat)
Temperature range	-20 to + 50°C (Alkaline cells) -20 to + 70°C (Lithium cells)
Recalibration (stability)	Recommended every 2 years
Response time	< 200 ms
Spectral Response	400-700 nm
Latitude capability	-90° to + 90°
Environmental Sealing	IP65 (shower and dust proof)
Sun status: contact closure CMOS	No sun = open circuit Sun = short circuit to ground
Sun status: logic voltage TTL	No sun = 0V Sun = 3.3V (10KΩ impedance)
Internal Battery	4 x 1.5V AA Alkaline cells
Power requirement	6.5 mA awake, <30 μA asleep
Battery Lifetime	1 year typical
Input Voltage - internal	3.6 to 15V DC
Input Voltage - external	5 to 15V DC
Mounting options:	1/4" Whit. std. camera socket, or 4 x M4 corner holes in box.
Size & Weight	120 x 122 x 95mm, 556g

Heated version type BF3H

Thermostatically controlled heater version. Specs as for BF3, plus the following. NB: Requires heater cable type BF3H-C.

Heater output	18W at < 5°C; 1.8W at 5-50°C 0 W (heater off) at >50°C
Lowest snow & ice-free temperatures	-20°C at 0 m/s wind speed -10°C at 2 m/s wind speed
Heater: max power	18 W at 12V DC, 1.5 A

Ordering Information

Sunshine Sensor type BF3
For simultaneous outputs of Total radiation, Diffuse radiation and sunshine status. Includes user manual, RS232 cable, BF3 CD-ROM with set-up software and all user documentation files. Output units can be preset to PAR, W/m2 (energy) or Lux by the user. NB requires connecting cables for use with SS1 SunScan Probe, or Data Logger.

Sunshine Sensor with Heater type BF3H
As BF3 above, with built-in thermostatically controlled heater. Includes heater cable for connecting to 12V DC power supply.

BF3 accessories
Cross arm type BF3-M. 1 metre length cross arm with pole mounting bracket and BF3 levelling device. Suitable for mounting BF3 onto Weather Station mast M2.
Spares kit type BF3-SP Suitable for 2 years' continuous operation.
Spare user manual type BF3-UM

BF3 cables
The BF3 Sunshine Sensor requires special connecting cables for use with the SunScan Canopy Analyser or a data logger.
BFDL cables have connectors suitable for connecting the BF3 Sunshine Sensor (3 channels) to a data logger. Cables terminate with bare wires suitable for direct connection to Logger terminals.
BFDL-XX Logger cable for BF Sensors
(Where XX denotes the cable length. Lengths of 5, 10, 25 and 50m are available, eg BFDL-10 indicates a 10m cable).
BFXL cables have connectors suitable for connecting the BF3 Sunshine Sensor to the SunScan Probe.
BFXL-XX BF3 connecting cable
(Where XX denotes the cable length. Lengths of 10, 25 and 50m are available, eg BFXL-10 indicates a 10m cable).

BF3 factory recalibration Recalibration of BF3 Sunshine Sensor, with calibration certificate.

SunScan System and BF2 Upgrades
SunScan Canopy Analysis System users with the BF1 sensor will benefit significantly from a BF3 replacement. BF2 users requiring BF3 capability may be able to upgrade. Please enquire.

References

- Wood, J., Muneer, T. (2002 In Press) "Evaluation of a new photodiode sensor for measuring global and diffuse irradiance, and sunshine duration". Journal Solar Energy Engineering.
- The following documents are available in electronic format on the BF3 CDROM, or for download from the Delta-T Devices website.

  BF3 User Manual, BF3 Technical Manual
  BF2-3 Optical Design Note

Data Sheet

WinDIAS 3

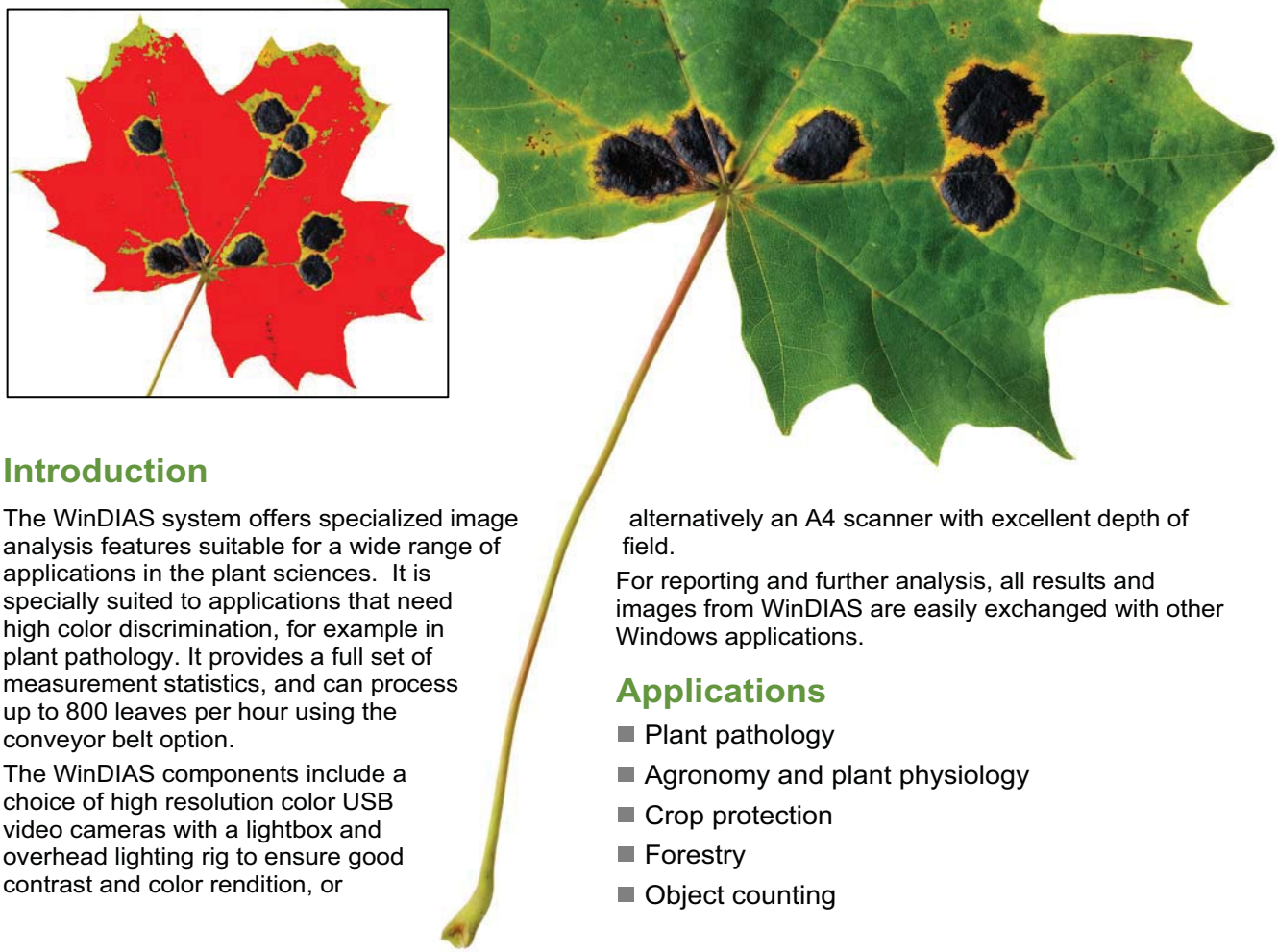
Image Analysis System

Image analysis system for leaves

NEW

WinDIAS provides high speed measurement and analysis of leaf area and leaf features, making it the ideal tool for plant pathology applications

- **Advanced leaf area meter plus perimeter, length, width, object count and more**
- **Automated measurement of diseased, healthy and pest-damaged leaf areas**
- **Point and click color selection**
- **Choice of camera or scanner systems**
- **Conveyor accessory for rapid processing of leaves**



Introduction

The WinDIAS system offers specialized image analysis features suitable for a wide range of applications in the plant sciences. It is specially suited to applications that need high color discrimination, for example in plant pathology. It provides a full set of measurement statistics, and can process up to 800 leaves per hour using the conveyor belt option.

The WinDIAS components include a choice of high resolution color USB video cameras with a lightbox and overhead lighting rig to ensure good contrast and color rendition, or alternatively an A4 scanner with excellent depth of field.

For reporting and further analysis, all results and images from WinDIAS are easily exchanged with other Windows applications.

Applications

- Plant pathology
- Agronomy and plant physiology
- Crop protection
- Forestry
- Object counting

WinDIAS Specifications

	Entry Level System	Standard System	Rapid System
Throughput (leaves/hour)	~50 (typical, depends on leaf size)	~150	~800
Resolution	2400 dpi max	2048 x 1536 pixels	1280 x 1024 pixels
Minimum object size	~ 0.02 mm	1 pixel	1 pixel
Maximum sample area	297 x 210 mm (A4)	300 x 295 mm	250 x 290 mm (conveyor) 250 x >1000 mm (long leaf mode)
Accuracy ■ area measurement ■ diseased/healthy area ■ long leaf mode	 ■ ± 1% typical ■ contrast dependent ■ not applicable	 ■ ± 4% typical ■ contrast dependent ■ not applicable	 ■ ± 4% typical ■ contrast dependent ■ ± 5% typical
Color depth	WinDIAS works in 24bit color space (16 million colors)		
Image file formats	.jpg, .bmp and .tif		
Operating system and drivers	Windows XP and Vista, but note that supplied camera drivers do not currently support 64 bit Vista		
Calibration ■ static measurements ■ conveyor measurements	 ■ against an object of known length, e.g. a ruler ■ not applicable		 ■ against a ruler ■ against a target of known area
Conveyor belt speeds	not applicable	not applicable	60/100/140/190 mm/s (20% faster for 60Hz model)

Specifications apply to a WinDIAS system using standard components supplied by Dynamax. Use of other cameras, lighting systems or camera stands may reduce accuracy due to reflections, poor contrast or image distortion.

Ordering Information

WinDIAS Systems

WinDIAS 3 Entry Level Image Analysis System type WD-E3 includes WD-SW3 Software and WD-FBS-1 Flatbed Scanner.

WinDIAS 3 Standard Image Analysis System type WD-S3-230 (230V/50Hz) includes WD-SW3 Software, WD-CS1 Camera Stand, WD-CAM-S1 USB Color Camera, WD-LEN-1 Precision Lens, WD-LB1-230 Lightbox, WD-OL1-230 Overhead Lights (with spare bulbs) and acrylic sheets.

WinDIAS 3 Rapid Image Analysis System type WD-R3-230 (230V/50Hz) contents as listed for Standard System, except camera type supplied is WD-CAM–R1 USB Color Camera, and includes CB-230/50 Conveyor Belt Unit and WD-RTS-1 Reference Target Set.

110V/60Hz Systems: For Standard System order **WD-S3-110**. For Rapid System order **WD-R3-110**

Individual Items

WinDIAS Software type WD-SW3 Software, Quick Start Guide and USB copy protection dongle

Camera Stand type WD-CS1

Camera type WD-CAM-S1 USB Color Camera for use with the Standard System

Camera type WD-CAM-R1 USB Color Camera for use with the Conveyor Belt Unit

Precision Lens type WD-LEN-1 for use with either WD-CAM-S1 or WD-CAM-R1 cameras

Lightbox type WD-LB1-230 (230V/50Hz)
- for 110V/60Hz systems order **WD-LB1-110**

Overhead Lights type WD-OL1-230 (230V/50Hz)
- for 110V/60Hz systems order **WD-OL1-110**

Conveyor Belt Unit type CB-230/50 (230V/50Hz)
- for 110V/60Hz systems order **CB-110/60**

Flatbed Scanner type WD-FBS-1

Reference Target Set type WD-RTS-1

Spares

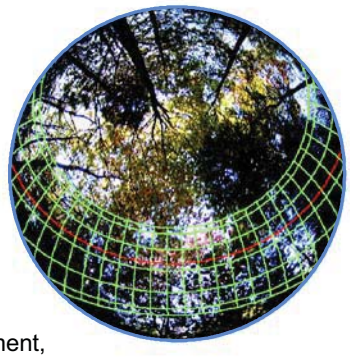
Spare Bulbs type WD-SP1-230 for Overhead Lights (230V/50Hz) - for 110V systems order **WD-LB1-110**

Spare Conveyor Belt Material type CBSP1 enough to make 10 pairs of belts

Pack of 10 Acrylic Sheets type WD-AS1

LAI - Leaf Area Index

There are more ways of getting to LAI than just measuring individual leaves. We also offer SunScan and HemiView - two innovative techniques for estimating LAI non-destructively.



Root Length

For root length measurement, we offer Delta-T SCAN. Please request a separate data sheet or see the web site.

Computers

WinDIAS systems can be supplied with a computer on request. Customers who purchase a computer directly from Dynamax will be supplied with a standard US PC running Windows XP or Vista, set up in English language mode.

CCM-200 plus Chlorophyll ContentMeter

Applications

- Non-Destructive Measurement
- Monitor Effects of Environmental Stress
- Evaluate and Determine Nutrient Performance and Requirements
- Nitr ogen and Fertilizer Management
- Anthocyanin Version Available

Features

- Up to 160,000 measurement storage
- Lightweight, Hand-Held Design Optimized for Field Work
- Display Chlorophyll Content Index and Calculated Sample Averages
- Built-in Data-Logging
- USB output
- Graphic data display
- S tand Alone Operation- No P .C. Required

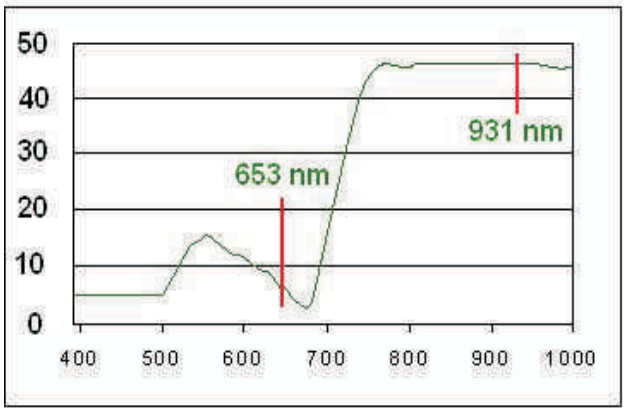
The New CCM-200 plus Chlorophyll Content Meter provides fast accurate, chlorophyll readings on the intact leaves of plants and crops. No more grinding or destructive assays! The measurement is rapid, accurate and simple to obtain, allowing researchers and agronomists to gather and evaluate mission critical data faster than ever before. Especially useful for improving and Fertilizer management programs with corn and wheat, the CCM-200plus can be used on a wide variety of both C and C plants. 3 4 The CCM-200 plus is designed to be the most repeatable portable chlorophyll content meter available. It incorporates a larger measuring area for signal averaging over a larger sample area. This approach provides a more reliable reading that takes into account small structure variations that can affect repeatability and reliability when compared to smaller area sampling. Accuracy of measurement is determined by correlation with chemical tests. Results have shown, that the CCM-200 plus is as accurate and any chlorophyll meter on the market and may be even more accurate on samples with very high chlorophyll content.
The CCM-200 plus has the largest on-board memory of any chlorophyll meter, storing up to 160,000 measurements or up to 94,000 measurements with GPS Data internally. Users can record large amounts of measurements without concern as the data is stored in non-volitile flash memory. Downloading of data is quick and easy through its universal USB 1.1. Employing a new MEDICAL grade strict tolerance LED source increases accuracy and insures consistent meter to meter readings.

CCM-200 Chlorophyll Content Meter

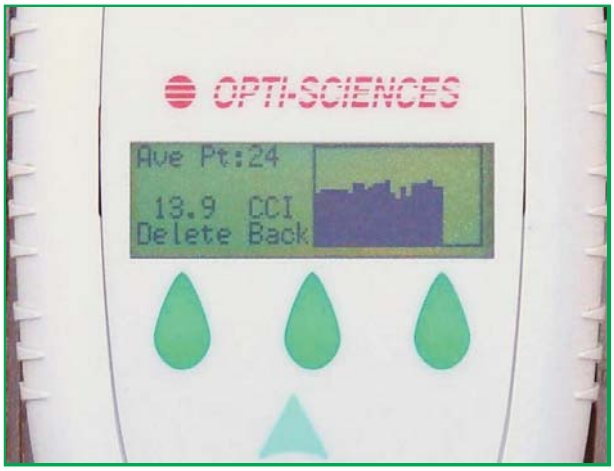
Nitrogen Status Agriculture Crop Production

Changes in chlorophyll content can occur as a result of nutrient deficiencies, exposure to environmental stress, exposure to certain herbicides, and differences in light environment during growth (shading). Chlorophyll content can be used to manage nutrient optimization programs that both improve crop yield and help protect the environment. Testing for herbicide damage can indicate the need for a change in herbicide selection or application methods; in order to maintain good weed control while having minimum impact on crop health.

Laboratory methods for determination of chlorophyll content are both time consuming and destructive to the sample. Typically a sample must be detached, ground up in a solvent, then assayed in a spectrophotometer. A sample can be measured only once precluding the cost effective monitoring of trends in chlorophyll content over the growing cycle. The CCM-200 plus provides non-destructive, rapid measurements with auto averaging calculations of relative chlorophyll content. It reduces the need for time consuming and costly chemical testing.



The CCM-200 plus accounts for both chlorophyll transmittance and leaf thickness



Technical Specifications

Measured Parameters: Optical absorbency in two different wavebands (653 nm and 931 nm). Designed to measure chlorophyll content and compensate for leaf thickness

Measurement Area: 3/8" diameter circle, (0.71mm^2)

Resolution: +/- 0.1 CCI Unit

Repeatability: +/- 1%

Source: (1) Medical grade LED (peak at 653nm)
(1) Infrared LED (peak at 931 nm)

Detector: Silicon photodiode with integral amplifier for absorptance measurement and source power monitoring for temperature compensation

Storage Capacity: between 94,000 and 160,000 measurements

Modes: single point measurement, 30 point averaging, thirty point averaging with elimination of flyers outside a two sima range.

User Interface: 128 x 32 pixel display, 6 keys for control and data manipulation, beep signal for status and warnings

Output: USB 1.1 and RS-232 interface for data transfer

Temperature Range 0-50 Deg C

Temperature Drift: Temperature compensated source and detector circuitry for minimum drift over full range.

Power Source: 9V Alkaline Battery

Auto Off Interval: 4 minutes (no key press or download)

New

OS1p Chlorophyll Fluorometer

Pulse Modulated, field portable

Great Science at an Affordable Price

Affordable - chlorophyll fluorometer for quantum photosynthetic Yield and ETR measurements as well as for Fv/Fm and Rapid Light Curves.

Fast - measure plant stress in a few seconds

High Precision - optional PAR Clip for more reliable field measurements

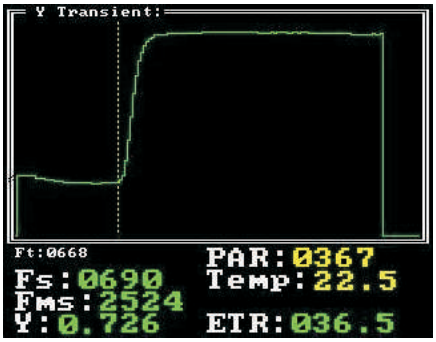
Easy to use - menu driven with color graphic screen.

Measurements are completed with a PAR Clip that offers true single handed operation.

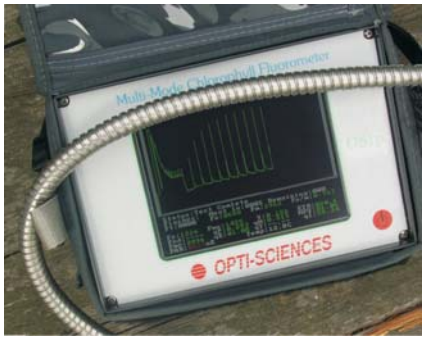
While Fv/Fm is probably the most often used fluorescent measurement, photosynthetic yield and ETR are likely the most useful measurements. These two parameters have successfully demonstrated the ability to measure more types of plant stress than Fv/Fm, and in some cases, detect stress earlier. Replacing the popular OS1-FL, the OS1p represents the next generation. This research grade instrument offers a number of new enhancements including: A color graphic touch screen for simple operation, a USB port, MMC/SD data card for file transfer and storage, and additional measuring protocols for added flexibility.

In addition, OSI has developed an innovative PAR clip for use with the OS1p that exceeds previous industry designs. The OSI PAR Clip includes a cosine corrected PAR sensor that is located to provide measurement of ambient light irradiation or internal actinic LED irradiation. Calibrations are made for sensor location and light source type. It also includes a solid state thermistor for more sensitive and reliable leaf temperature readings.

The mechanical design of the PAR Clip is also unique. This PAR clip is designed for one handed operation and it will not open at inappropriate times.



Yield and ETR measuring screen Y is Yield F/Fm' and Fms is Fm'



OS1p showing touch screen

Optional - Standard PAR Clip mounted on articulating arm stand for lab work.

Chlorophyll fluorescence is the method of choice for measuring most types of plant stress and monitoring plant health. The reasons for this are simple. Fluorometers are truly field portable, stress measurements only take a couple of seconds, and instrumentation is very cost effective.

An up to date compilation of papers related to plant stress measurement is available from Opti-Sciences free of charge. The compilation lists the value and limitations of the technology.

Opti-Sciences line of Chlorophyll Fluorometers are superb for field work, lab work, and even teaching. Instruments are available to meet most needs and budgets.

Parameters Measured and Protocols included
Y: Photosynthetic Yield (or)F/Fm')
ETR: Electron transport rate (w/optional clip)
PAR: Photosynthetically Active Region value (with optional PAR clip)
T: Leaf temperature (with optional PAR clip)
Fv/Fm: Photochemical efficiency of PSII
Fo: Minimum fluorescence
Fm: Maximal fluorescence
Fv: Variable fluorescence
Fms (or Fm'): Maximal fluorescence with actinic illumination
Fs (or F): Fluorescence under steady state condition (prior to saturation pulse)

New Parameters & Protocols
Choose Kramer lake model or Hendickson - Klughammer lake model quenching parameters at time of purchase.

qL: Photochemical quenching lake model (Kramer)
Y(NPQ): Non-photochemical quenching related to photoprotection. (Kramer equations & Klughammer equations)
Y(NO): Non-photochemical quenching not related to photoprotection. (Kramer equations & Klughammer equations)
Y(II): (Kramer equations & Klughammer equations are the same
NPQ: (Klughammer only)
Multiflash: This is a protocol for correcting quantum photosynthetic yield and ETR under high actinic lighting conditions. It has been found that under high actinic light, it is not possible to fully saturate all PSII reaction centers with saturation pulses.
RLC: Rapid light curves.

Excitation Sources:
Saturation pulse New generation white light LED with 690 nm short pass filter.
0- 11,000 uE
Modulated light Red or blue (choice at purchase) 660 nm LED with 690 nm short pass filter, or blue 450nm diode.
Actinic light source: New generation white light LED to 0- 3000 uE. 32 adjustable steps

Detection method: Pulse modulation method.
Detector & Filters: A PIN photodiode with a 700 ~ 750 nm bandpass filter.

Sampling Rate:
Test Duration: Adjustable from 2 second to 16 hours.

Storage Capacity: 1 Gigabyte of non-volitile flash memory, supporting unlimited data sets and traces
Digital Output: USB, SD/MMC data card, and RS232.

User Interface:
Display: Graphic color touch screen
Menu driven touch screen.

Power Supply: Internal 12V, rechargeable nickel metal hydride battery.

Battery Life: Up to 8 hours of continuous operation.

Dimensions: 7 in x 5.5 in x 3.25 in. or 17.8 cm, x 14 cm, 8.3 cm.

Weight: with fiber optic probe - 3 lbs or 1.36 kgs. with fiber optic probe and PAR Clip- 3.6 lbs or 1.62 kg

Auto-switching from 10 to 10,000 points per second, depending on phase of test.

OS-30p Chlorophyll Fluorometer

Plant Stress Detection with Fv/Fm

Fv/Fm - A Measure of Maximum Potential Quantum Efficiency

Fv/Fm is the most used parameter for plant stress detection in the world, and it is a robust way to detect stress that affects photosystem II.

Handy, ergonomic design...

Plant Stress
Agriculture
Forestry
Ecology
Physiology

Pulse Modulated, Hand-Held

The OS-30p is a low-cost, hand-held Chlorophyll Fluorometer optimized for rapid field measurements of plant stress. The lightweight, ergonomic design along with the accurate fluorescence detection system help make the OS-30p an invaluable and reliable evaluation tool in a wide range of research disciplines including: Plant Physiology, Horticulture, Agronomy and BioTechnology.

Both the OJIP and the Fv/Fm test modes allow for in-depth investigation into the photosynthetic process. Test data is displayed conveniently in graph form as well as numerically. Parameters measured include: Fo, Fm, Fv/Fm, Ft, T ½ as well as basic OJIP & Area above the curve.

Two key design features implemented with the user in mind are sure to facilitate instrument operation and sample handling. The new integral probe makes leaf orientation and measurement faster, easier and less cumbersome. An additional benefit of the built in probe is it eliminates the risk of the probe being dropped, misplaced or otherwise damaged.

The second key feature is the on-board Help menu. If you're stranded in the field without the manual, no need to worry, our comprehensive text menus will guide you through any problem and even help inexperienced users complete their tests.

OS-30p Chlorophyll Fluorometer

Fast Accurate Affordable Simple to Operate

Pulse Modulated, Hand-Held

For over fifteen years Opti-Sciences has been providing advanced and reliable Chlorophyll Fluorometers to the Plant Sciences community. Our mission to design a hand-held modulated fluorometer that could fit a wide range of laboratory, field research and teaching applications has finally been realized with the OS-30p. The accuracy and performance are of the highest possible quality yet the price remains extremely affordable. Furthermore, it is practical, user-friendly and will benefit nearly every researcher whether you've just starting out with Chlorophyll Fluorescence or have been using the technique for years.

The OS-30 offers on-board storage capacity of over 8,000 measurements. A rechargeable battery with up to 8 hours of field use make those frustrating trips back to the lab a thing of the past. Data can be exported to a PC using the built in computer output and Opti-Sciences Data Capture software. As always, we include a cable, software and battery charger at no extra cost. 10 dark adaption leaf cuvettes are also included.

Test data can be reviewed or deleted simply by using the scroll keys. A straight forward keypad outlay allows users to quickly chose test mode, set test duration, light intensity and other test parameters. The large, backlit graphical display is readable in dark or light conditions.

Technical Specifications

Test Modes:
Fv/Fm
Fast Kinetics - Basic OJIP

Excit ation Source:
Solid st ate 660nm source
Modulation beam adjust able .2 to 1.0 uE
Saturation/Actinic Intensity adjust able from 100 ~ 3,000 uE depending on test mode

Detection method: Pulse Modulated w/ High Resolution sampling mode for Kautsky Induction curve recording.

Detector and Filters: A PIN photodiode with a 700 ~ 750 nm band pass filter .

Sampling Rate: Variable from 10 to 30,000 points per second depending on phase of test.

Test Duration: Adjustable from 2 seconds ~ 255 seconds

Storage Cap acity: 512 Kb battery backed up RAM, supporting up to 8,190 test dat a set s, and 32 traces of up to 255 seconds each.

Digital Output: RS-232 port.(USB adapters are available)

User Interface:
Display: 128 x 64 dot backlit graphics display
Keyboard: 13 keys dedicated function layout
Fiber Optic Cable Option: 1 meter in length

Power Supply: Rechargeable NiMH Battery Pack with charger

Battery Life: 8 hours

Dimensions: 18 cm x 7 cm x 6 cm.

NEW

OS5p Pulse Modulated Chlorophyll Fluorometer

The New Standard in Portable Fluorometers

Detection of Almost All Types of Plant Stress - **The Most Advanced Portable System Available.**

Wider Range of Automated Programmable Testing Protocols – **More Than Any Other Portable Fluorometer**

New Technology – **Dramatic Innovations Improve Measurement Reliability**

Rugged Field Portable – **Designed for Extended Field Studies and Remote Locations**

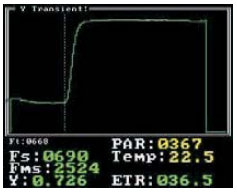
Better tests allow better science

Test parameters and protocols offered with the OS5p

The Most Popular Tests:

Y: (or ΔF/Fm' or (Y(II)) quantum photosynthetic yield of PSII (light adapted)
Fv/Fm: Maximum quantum yield - Photochemical efficiency of PSII (dark-adapted)
ETR: Electron Transport Rate (w/optional PAR clip)
PAR: Photosynthetically Active Radiation value
(with optional PAR clip)
T: Leaf temperature (with optional PAR clip)

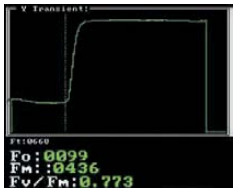
ΔF/Fm'



New Tests:

Fv/Fm

FRFex360/FRFex440 for nitrogen stress testing. This test separates nitrogen and sulfur stress (with optional Universal PAR Clip).
Stepped Actinic test for light curves, rapid light curves and non-sequential light curves
Multi-flash Fm' correction for more reliable photosynthetic yield and ETR measurements under high light stress conditions
Automated Programmable Quenching tests for stress testing, evaluation of photoprotective mechanisms, state transitions, and photoinhibition. The OS5p includes both Kramer and Klughammer Lake model parameters



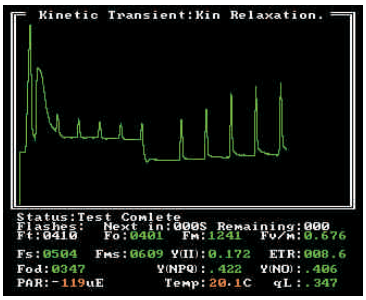
Light Curves

Advanced lake and puddle model quenching parameters

Kramer Lake model quenching parameters (2004)

Puddle Model

Y(II) Quantum photosynthetic yield
qL Photochemical quenching
Y(NPQ) Photoprotective non-photochemical quenching
Y(NO) All other non-photo-protective non-photochemical quenching



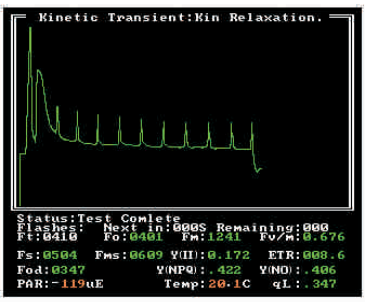
Kughammer simplifed lake model parameters (2008)

Y(II) Quantum photosynthetic yield
Y(NPQ) Photoprotective non-photochemical quenching
Y(NO) All other non-photo-protective non-photochemical quenching
NPQ: Non-photochemical quenching NPQ=Y(NPQ)//Y(NO)

Kramer Lake Model

Puddle model quenching parameters

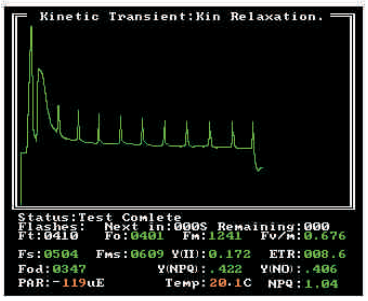
qP: Photochemical quenching
qN: Non-photochemical quenching
NPQ: Non-photochemical quenching
- q_E Photoprotective non-photochemical quenching
- q_T The portion of NPQ related to state transitions
- q_I The portion of NPQ due to photo-inhibition and photodamage



Other Parameters:

Klughammer Simplified Lake Model

Fo: Dark-adapted initial fluorescence value
Fm: Maximal fluorescence
Fv: Variable fluorescence
Ft: Terminal fluorescence value
Fod: (or Fo') quenched value of the Fo used in many quenching calculations.
Fms: (or Fm') Maximal fluorescence after first saturation pulse
Fs: (or F) Fluorescence under steady state condition (prior to saturation pulse)
OJIP curves, O, J, I, P, Area above the curve, & time to P



GFP-Meter

Measure Flourescent Dyes, Proteins, & Markers

Applications

- Measure Green Fluorescent Protien
- Detect Fluorescent Markers, Dyes, Fluoreoscein and Rhodamine
- Distinguish Between GMO and Non-GMO (Genetically Modified Organisms)
- Gene Expression Studies
- Parts Inspection and Contamination Detection

Features

- Non-Destructive Measurement
- Lightweight, Hand-Held Design Optimized for Field Work
- Accurate, Reliable, and Easily Repeatable Measurements
- Internal Data-Logging
- Stand Alone Operation- No P.C. Required

The GFP-Meter is a General Purpose hand-held fiber-optic fluorometer supporting a wide variety of solid state source and detector combinations from UV to IR. Detection of Green Fluorescent Protein, Rhodamine, and Fluroescein are some of the most requested configurations. The unit is designed to perform sensitive measurements with minimal excitation energy. A solid state source and detector pair with thin film interference filters is used for better signal separation and is optically monitored for drift. The provided flexible fiber-optic probe can be used with gaseous, liquid, or solid samples and a selection of sample clips are available. Custom sample chamber/clips are also available.

The GFP-Meter set for Green Fluorescent Protein facilitates transgenic plant studies, allowing thousands of measurements under field & laboratory conditions. When set for Dyes such as Rhodamine or Fluorescein, the GFP-Meter can detect extremely low concentrations for better detection of organic material and contaminants.

The GFP-Meter is lightweight (1kg) and battery powered with a rugged weather resistant plastic case for field and industrial use. Data logging is built in recording of up to 2730 sample points grouped into up to 60 different "Files" for easy classification. Each data point is stored with time and a calibration status stamp. Stored data can be reviewed on its 16 x 4 line LCD display without the use of an external PC. The data can also be transferred from the unit via a standard RS-232 port and supplied windows compatible software.

GFP-Meter Measure Fluorescent products in minute concentrations

Protein GMO Dyes Contaminants

The GFP-Meter is a self-contained, hand-held fluorometer that utilizes a modulated detection system to compensate for stray light and temperature drift. The probe-based design allows the user to measure both intact samples and surfaces. Furthermore, the small probe makes it possible to use the instrument on a variety of plants such as Arabidopsis and Maise as well as access hard to reach locations for inspection and detection.

The GFP-Meter combines advanced measurement performance with user-friendly features making it a practical, research grade instrument that is easy to use and understand. On-board data-logging, an RS-232 port, PC software and a long-life rechargeable battery are included convenient features found in the GFP-Meter.

The GFP-Meter ships with a user selected Source/Detector filter pair, 4 - AA Batteries, Fiber-probe, sample cuvette, RS-232 cable, PC software, and a users manual.

Suggested Reading:

Haseloff J. and K.R. Siemering. 1998. The uses of GFP in plants. In: Chalfie M. and S.R. Kain, eds. Green Fluorescent Protein: Properties, Applications, and Protocols. Chichester, England, Wiley and Sons. 191-220.

Leffel S.M., S.A. Mabon and C.N. Stewart, Jr. 1997. Applications of green fluorescent protein in plants. BioTechniques 23:912-918.

Niedz R.P., M.R. Sussman and J.S. Satterlee. 1995. Green fluorescent protein: an in vivo reporter of plant gene expression. Plant Cell Rep. 14:403-406.

Stewart C.N., Jr. 2001. The utility of green fluorescent protein in transgenic plants. Plant Cell Rep. 20:376-382.

Technical Specifications

Source: Solid State LED with Band Limiting Filter. Output Compensated for Battery Voltage & Temp drift.

Detector: Solid State, High Sensitivity Detector. Band Limiting Filter Sets Detection Range.

Detection System: Digitally Controlled, Modulated Detection System for Optimal Rejection of Background Light and Maximal Drift Reduction.

Sample Interface: Bifurcated Fiber-Optic Probe, 4mm bundle diameter. (sample end available in multiple custom configurations)

Controller: 16MHz RISC Processor

User Interface: 4x3 Key Pad 16x4 Line LC Display

Memory: 8KB Non-Volatile EEPROM. Storage for 2730 Data Sets.

Output: RS-232 Level Serial Port. Data Format- ASCII Plain Text Compatible with most Terminal Programs.

Power Source: 4 “AA” Batteries. Provides 20 to 30 hrs of run time.

Size: 21cm x 8cm x 5cm

Weight (with battery): 1Kg

Operating Temperature Range: 0-70 Deg C

Items Included: GFP-Meter with user selected Source/Detector Filters, Battery, Fiber-probe, RS-232 cable, Instruction Manual.

Serving all of Canada:

Hoskin Scientific Limited
4210 Morris Drive
Burlington, ON L7L 5L6 CANADA

Vancouver (604) 872-7894 • Burlington (905) 333-5510 • Montreal (514) 735-5267

Web Site: www.hoskin.ca

Hoskin Scientific Ltd

SPAD 502 Plus Chlorophyll Meters

The SPAD 502 Plus Chlorophyll Meter instantly measures chlorophyll content or "greenness" of your plants to reduce the risk of yield-limiting deficiencies or costly overfertilizing. The SPAD 502 Plus quantifies subtle changes or trends in plant health long before they're visible to the human eye. Non-invasive measurement; simply clamp the meter over leafy tissue, and receive an indexed chlorophyll content reading (0-99.9) in less than 2 seconds. Assess nitrogen needs by comparing in-field SPAD readings to university guidelines or to adequately fertilized reference strips. Research shows a strong correlation between SPAD measurements and leaf N content.

New features in the SPAD 502 Plus include:
- Trend graphing stores and displays up to 30 measurements
- Waterproof design

The SPAD 502 Plus meter can be purchased with or without a built-in data logger. The data logging version (Item 2900PDL) allows you to compile readings for statistical analysis. Includes an RS-232 port for communicating with a PC* and/or portable GPS receiver**. Use geo-referenced data to correlate N measurements to yield maps or download the data into mapping software. This robust field-data collection device has a capacity of 1,488 measurements when coupled with a GPS receiver or 4,096 measurements when used without GPS. Requires software running on Windows 98 or higher. GPS/DGPS cable required for geo-referenced operation.

GMP343 Carbon Dioxide Probe for Demanding Measurements

The GMP343 is available as an open path, diffusion aspirated model (left) and as a flow-through model (right).

Features/Benefits

- Excellent accuracy and stability
- Vaisala CARBOCAP® Sensor, a silicon-based non-dispersive infrared (NDIR) sensor
- A single-beam, dual-wavelength CO_2 measurement with no moving parts
- Compensation options for temperature, pressure, humidity and oxygen
- Low power consumption and heat emission
- Designed for outdoor use
- Compact and lightweight

The Vaisala CARBOCAP® Carbon Dioxide Probe GMP343 is an accurate and rugged probe-type instrument for ecological measurements. Typical applications include:

- CO_2 soil respiration
- Ambient CO_2 monitoring
- Plant growth chambers
- OEM applications

Open path, diffusion aspirated probe

The product concept eliminates the need for bulky and power-consuming gas sampling systems. The power consumption of the GMP343 itself is low, even below 1 W.

Novel solution for soil respiration measurements

The use of diffusion aspiration eliminates the measurement error caused by pressure differences often present in pump-aspirated measurement systems.

Rugged metal structure

The body of the GMP343 is IP67-classified and suitable for harsh environments. The sensor's diffusion filter protects it from dust and dirt. Heated optics prevent the formation of condensation.

User-configurable measurement

The GMP343 can output both numerically filtered and raw measurement data. The instrument can also compensate the measurement with an internal temperature measurement and user-set relative humidity, pressure and oxygen values.

MI70

In combination with an MI70 indicator, the GMP343 provides an ideal tool for accurate in-situ measurement. The MI70 is used as a display, communication, and data-login device. To achieve most accurate measurements, a Vaisala HMP75 humidity probe can be connected to the MI70 indicator for automatic humidity compensation. In that case a manual compensation is not needed. The optional MI70 Link Windows® software allows transferring logged and real-time data of the GMP343 from the MI70 to a PC.

Calibration

Each GMP343 is calibrated using ±0.5 % accurate gases at 0 ppm, 200 ppm, 370 ppm, 600 ppm, 1000 ppm, 4000 ppm and 2 %. Calibration is also done at four temperature points, -30 °C, 0 °C, 25 °C and 50 °C. If needed, the customer can recalibrate the instrument using the multipoint calibration (MPC) feature allowing up to 8 user-defined calibration points.

With the optional mounting flange, the GMP343 can for example be installed directly into a soil respiration box. The diffusion-aspirated probe eliminates sampling systems and errors related to pressure differences caused by pumps.

Technical Data

Performance

Measurement range options: 0 ... 1000 ppm, 0 ... 2000 ppm, 0 ... 3000 ppm, 0 ... 4000 ppm, 0 ... 5000 ppm, 0 ... 2 %

Accuracy (excluding noise) at 25 °C (77 °F) and 1013 hPa after factory calibration with 0.5 % accurate gases with different range options

0 ... 1000 ppm	±(3 ppm + 1 % of reading)
0 ... 2000 ppm - 0 ... 2 %*	±(5 ppm + 2 % of reading)

*Accuracy below 200 ppm CO_2 not specified for 2 % range option

Noise (repeatability) at 370 ppm CO_2

with no output averaging	±3 ppm CO_2
with 30 s output averaging	±1 ppm CO_2

Temperature

Effect on accuracy with temperature compensation:

CO_2 range options	0 ... 1000 ppm	0 ... 2 000 - 5000 ppm	0 ... 2 %
Temperature °C (°F)	Accuracy (% of reading)		
-10 ... +40 (+14 ... +104)	±0.5	±1	±2
-40 ... +60 (-40 ... +140)	±2	±3	±4

For readings below 200 ppm CO_2 ±5 ppm CO_2

Temperature compensation is performed by an integrated Pt1000 element

Pressure

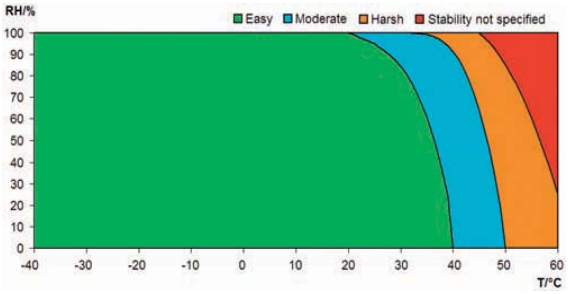
Effect on accuracy with pressure compensation:

CO_2 range options	0 ... 1000 ppm	0 ... 2000 - 2 %
Pressure (hPa)	Accuracy (% of reading)	
900 ... 1050	±0.5	±1
700 ... 1300	±1	±2

Integrated pressure sensor is not included in GMP343

Long term stability: see graph below

easy	<±2 % of reading / year
moderate	<±2 % of reading / 6 months
harsh	<±2 % of reading / 3 months



Response time (90 %)

Diffusion model Filter attached	Averaging (s)	Response (s)
Yes	0	75
Yes	30	82
No	0	<2
No	30	30

Flow-through model Gas flow (l/min)	Averaging (s)	Response (s)
0.3	0	26
0.3	30	44
1.2	0	8
1.2	30	23

Warm-up time

full accuracy ±0.5 %	10 min
full accuracy	30 min

Operating Environment

Temperature	
operating	-40 ... +60 °C (-40 ... +140 °F)
storage	-40 ... +70 °C (-40 ... 158 °F)
Humidity	see graph 'GMP343 Operating Conditions'
Pressure	
compensated range	700 ... 1300 hPa
operating	<5 bar
Gas flow for flow-through model	0 ... 10 liters/min
Electromagnetic compatibility	EN61326, Generic Environment

Inputs and outputs

Operating voltage	11 ... 36 VDC
Power consumption	
without optics heating	<1 W
with optics heating	<3.5 W
Analog outputs	
Current output	
range	4 ... 20 mA
resolution	14 bits
max. load	800 Ohm @ 24 VDC, 150 Ohm @ 10 VDC
Voltage output	
range	0 ... 2.5 V, 0 ... 5 V
resolution	14 bits (13 bits with 0 ... 2.5 V)
min. load	5 kOhm
Digital outputs	RS485, RS232

Materials

Housing	anodized aluminium
Filter cover	PC
IP classification	
Housing (cable attached)	IP67
Diffusion filter (weather protection)	IP65
Diffusion filter (sintered PTFE)	IP66
Cable connector type	8-pin M12
Weight (probe only)	360 g

Options and accessories

Wall mount bracket	GMP343BRACKET
Mounting flange	GMP343FLANGE
Standard diffusion filter (weather protection, IP65) +filter cover	GMP343FILTER
Diffusion filter (sintered PTFE filter, IP66) + filter cover	215521
Calibration adapter (for the diffusion model)	GMP343ADAPTER
Junction box	JUNCTIONBOX-8
Probe cables	
2m	GMP343Z200SP
6m	GMP343Z600SP
10m	GMP343Z1000SP
PC connection cable, 2m	213379
MI70 connection cable, 2m	DRW216050SP
USB adapter (USB-D9 Serial connection cable)	219686
Soil adapter kit for horizontal positioning	215519
Soil adapter kit for vertical positioning	215520

Dimensions

Probe dimensions in mm (inches)	
length	180 (7.1)
diameter	55 (2.2)

For full technical specifications, see the User's Guide

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Specifications are subject to change without prior notice.
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DELTA-T DEVICES

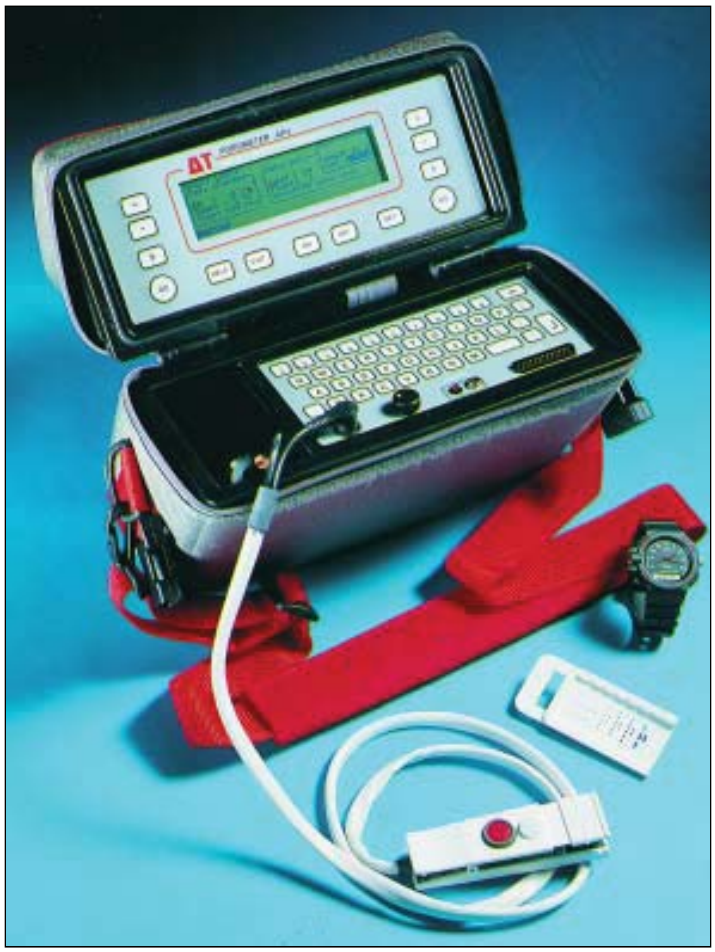
AP4 Porometer

PRODUCT INFORMATION

The AP4 Porometer measures stomatal aperture in terms of leaf conductance to water vapour.

This is a major determinant of water loss from plant leaves and of CO_2 uptake in photosynthesis.

- *Direct readout of conductance or resistance*
- *Simple and rapid calibration in the field*
- *Minimises leaf stress during measurement*
- *Outstanding value and ease of use*



Applications

Loss of water vapour through plant leaf stomata is one of the critical factors linking transpiration with ambient temperature, pressure, humidity and wind speed. The stomata are sensitive to light, relative humidity (RH), carbon dioxide (CO_2), water stress, pathogens and pollutants. The AP4 Porometer makes accurate, repeatable and convenient field measurements of stomatal conductance using the cycling diffusion principle. When combined with leaf area and leaf temperature measurement, the instrument enables water loss from a whole plant or crop canopy to be estimated.

The AP4 is therefore an invaluable tool for quantifying the effect of various influences on stomatal behaviour. It also has an important role to play in comparing the performance of different crop varieties in response to environmental variations and stresses.

Practical Experience The theory behind the cycling porometer is well understood (ref. 1), and is backed by Delta-T's considerable manufacturing experience of this type of instrument through four evolutionary stages. Over 1000 Delta-T porometers have been used worldwide since the first was devised by Dr. J. L. Monteith in 1974 (ref. 2).

Easy and convenient use

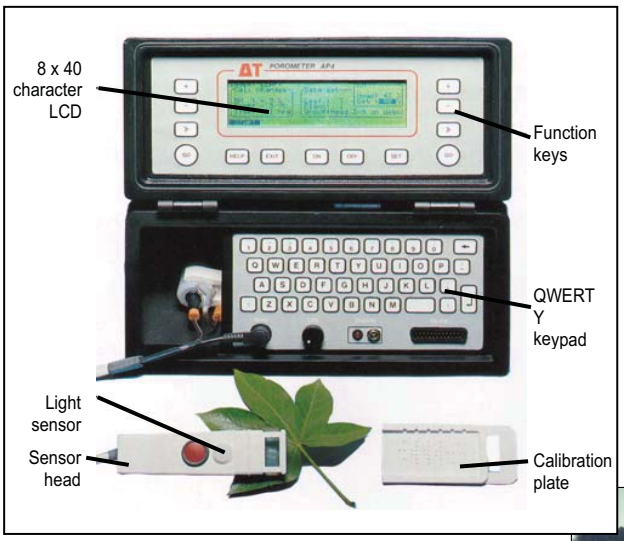
The innovative design of the AP4 provides users with logical, convenient operation and a comprehensive range of features and functions. In particular, the AP4 offers an automated, rapid cycle that gives temperature-compensated readings, and straightforward calibration.

New users can quickly make effective use of the AP4, without a deep knowledge of all the options available to the more experienced user. A [HELP] button provides operating assistance, especially useful for field work, while a [SET] button conveniently recalls operating settings stored previously.

In use, the AP4 is carried on a shoulder strap in its own protective carrying case, with the keyboard, control buttons and display at a convenient working level. The sensor head, on a flexible cable, is simply clipped on to the leaf to be measured. Once the instrument has been initialised, a [READ] button on the head allows single-handed operation. Successive readings can be taken, evaluated and stored just by pressing this one button. Stable readings are audibly indicated by a double beep'.

Step-through procedures from menus displayed on the LCD guide the user through the processes of calibration, taking readings, and the review and output of stored data.

HOSKIN SCIENTIFIC



Direct calibration

The direct calibration technique used in the AP4 gives much greater confidence in the absolute accuracy of its readings than is possible in practice with other systems.

The AP4 is supplied with a moulded polypropylene calibration plate with six groups of holes; the rate of diffusion of water vapour through these holes has been carefully verified. Water vapour is provided by backing the plate with dampened paper. The sensor head is clipped onto the calibration plate, and readings are stored from each of the six standard calibration positions.

Calibration is a simple process, and easily undertaken in the field. It should be carried out at the start of a measurement session, and when necessitated by a change in temperature, or by moving to a new RH cycling level, or by changing to the alternative cup on the sensor head.

Dynamic diffusion and steady state porometers compared

Porometry

Porometry is the study of gas diffusion through pores, particularly through leaf stomata. Since plant transpiration is mainly controlled by the opening and closing of stomata, the use of porometers is vital to many areas of plant research.

Most field measurements are currently made by diffusion porometers, using either the dynamic or steady state measurement principle. Dynamic diffusion porometers, such as the Delta-T AP4, are characterised by simplicity, unstirred leaf chambers, and the need for frequent but easy recalibration using plates with known diffusion resistances. Steady state porometers are comparatively complex, they require a vigorously stirred leaf chamber and their recalibration, while infrequent, can be difficult.

Relative Strengths

Accuracy: Under laboratory conditions, the two systems are comparable, though the steady state can be significantly more accurate at very high diffusion conductances when carefully calibrated.

Under field conditions, the situation changes. The accuracy of the Delta-T system can be maintained by simply recalibrating in the field whenever appropriate. In the steady state system, accuracy depends on the absolute accuracy of the RH measurement: an error of more than ±18% in the diffusion reading can be caused by a ±3% RH error (refs. 3, 4). When taking measurements in the field on leaves, the possibility of contamination will usually limit confidence in the absolute RH measurement to ±4%, even with careful and frequent laboratory recalibration.

Conditions within a porometer chamber can occasionally cause the stomata to close before a reading is taken. These are more likely to be present in a chamber where the leaf is stressed by the increased water loss associated with vigorously stirred steady state systems.

Resolution: Dynamic and steady state porometry systems offer similar resolution: approximately 0.5 $mmol.m^{-2}.s^{-1}$.

Speed: Both systems enable a reading to be taken within about 15 seconds for a highly conductive leaf, and within about 60 seconds for a highly resistive leaf.

Convenience: Both systems provide direct readout of stomatal conductance units, but the AP4 also features a simple comprehensive graphic display of all relevant reading information. The moulded plastic AP4 sensor head weighs only 130g – less than 1/3 of many steady state porometers.

Sampling area: Because the chamber in a dynamic system is unstirred, it is not practical to use large sampling areas in conjunction with a small RH sensor. However, users' experience suggests that this is a very minor inconvenience, occasionally requiring more samples to be taken.

Price: Generally, dynamic porometers are less expensive because they do not require such elaborate leaf chambers or expensive gas flow meters.

Ease of use, reliability and economy without compromising on accuracy continue to make dynamic diffusion porometers the first choice for professional scientists worldwide.

Compact sensor head

The lightweight, compact AP4 sensor head enables reliable and quick measurements, even in small or dense canopies, with minimum stress on the leaf.

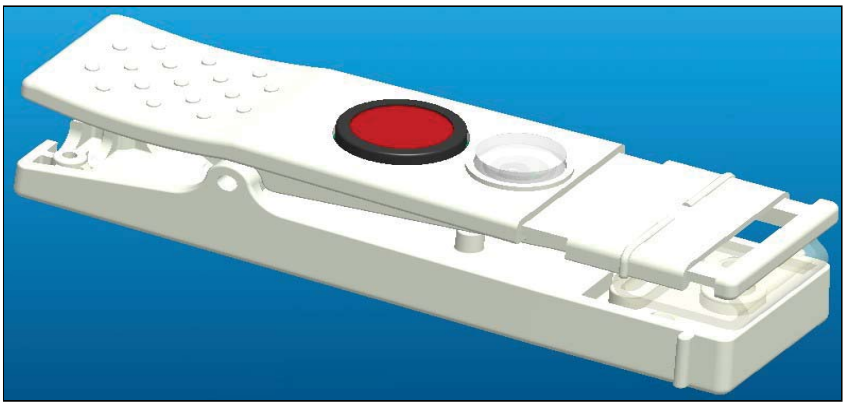
Made from low water absorption polypropylene, the head contains two cups (cuvettes): one slotted, the other circular, to suit different leaf shapes. A shuttered cover lets the user check leaf alignment. A silicone rubber seal presses gently onto the leaf surface, defining the sample area.

New for 2004

The sensor head mouldings have been redesigned to incorporate several further mechanical enhancements, e.g.

- Strengthened side ribs and hinge mounting
- Textured thumb grip
- Improved cable retention and strain relief

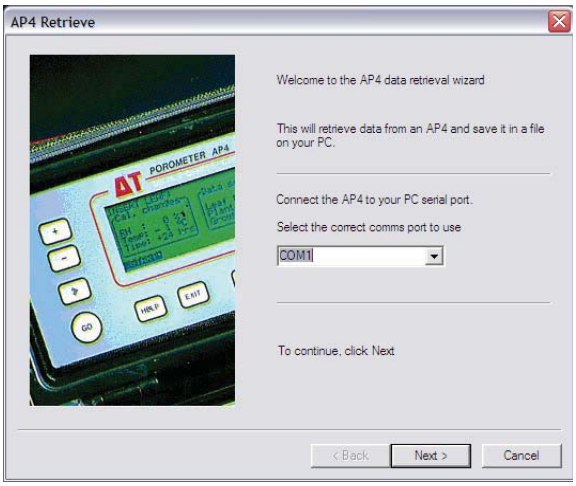
The head contains fast response sensors to measure cup and leaf temperatures, allowing automatic temperature compensation to be applied (ref 3). White insulating materials reduce cup heating by bright sunlight, while a PAR photodiode sensor (Photosynthetically Active Radiation) measures light incident on the leaf.



Measurement units

The AP4 lets you choose whether to work in terms of stomatal conductance or resistance, and in "velocity" or mole units. Mole units offer comparability with biochemical units in photosynthesis, for example the moles of biomass created, or the flux density of PAR quanta. They have the advantage of being independent of pressure*, and only weakly dependent on temperature, whereas velocity units depend on both. The AP4 refers all readings to the ambient temperature and pressure.

* Changes in barometric pressure between a calibration and actual measurement will affect resistance readings: a change of 1kPa can cause a 1% error in measured resistance. An extreme change in the weather could have this effect, but altitude is normally a greater factor, the rate of change being 1kPa per 100 metres. The Wristwatch Barometer type PBR1, is suitable for monitoring local pressure (see Ordering Information).


AP4 Retrieve
Welcome to the AP4 data retrieval wizard
This will retrieve data from an AP4 and save it in a file on your PC.
Connect the AP4 to your PC serial port.
Select the correct comms port to use
COM1
To continue, click Next
< Back
Next >
Cancel

Data handling

Onboard memory provides a storage capacity of up to 1500 readings, with a notes facility. Data is read out to a computer, printer or pocket terminal through the RS232 link. Data formats are suitable for direct entry to standard analysis software including Excel.

A complete set of data comprises the reading, reading labels, time, light level, temperature and relative humidity. Up to 30 characters of notes for each reading can be added using the keypad.

New for 2004

- RETRIEVE software has been updated for Windows XP and Windows ME compatibility.

3	GROUP 6:	Pinot	Date :	10/07/2004	Set RH:	50%	Units:	mmol/m^2/s
4							Press:	1000 hPa
5								
6	Time	Plant	Leaf	Conduct.	Cup T	Cup-Leaf	Light	Notes
7	15:52	1	1	17.7	23.8	0.1	810	upper - centre of plot
8	15:53	1	2	216.0	24.0	0.2	320	lower
9	15:53	1	3	21.2	24.2	0.3	570	upper
10	15:54	2	1	435.0	24.4	0.4	340	lower
11	15:55	2	2	15.6	24.5	0.3	660	upper - edge of plot
12	15:55	2	3	131.0	24.5	0.6	480	lower

Porometer type AP4 Specifications

Parameter	Reading range	Resolution [1]	Accuracy [2]	Test Conditions Reading range
Conductance	5.0 -1200 mmol m^{-2} s^{-1}	0.1 - 10	±10 %	5 - 800 mmol m^{-2} s^{-1}
			±20 %	800 - 1200 mmol m^{-2} s^{-1}
Conductance	0.25 - 30.0 mm s^{-1}	0.01 - 0.1	±10%	0.25 - 20 mm s^{-1}
			±20 %	20 - 30 mm s^{-1}
Resistance	0.2 - 40 s cm^{-1}	0.01 - 0.1	±10 %	0.5 - 40 s cm^{-1}
			±0.2 s cm^{-1}	0.2 - 0.5 s cm^{-1}
RH	0 - 100%	0.1	±4%	
Cup temp.	-5 - +55 °C	0.1	±0.7 °C	0 - 50 °C
Cup-leaf temp.	-5 - +5 °C	0.1	±0.2 °C	0 - 50 °C
PAR flux [3]	0 - 2500 µmol m^{-2} s^{-1}	10	±15%	
Pressure [4]	600 - 1200 hPa, settable in steps of 5 hPa			
RH cycle level	20 - 80 %RH, settable in steps of 5%			

Notes:

[1] Resolution varies with the magnitude of the value obtained. The range shown corresponds to the reading range. In relative terms, the resolution is better than 2%, but at least the smallest amount shown.

[2] The stated accuracy applies over the range of the calibration plate and for optimum cup conditions, i.e. from +10 to -5 °C difference between actual cup temp. and that existing at calibration, and for +2.5 to -2.5 °C difference between leaf and cup temperatures.

[3] Spectral and cosine responses are approximate only.

[4] Ambient pressure may be read from a Wristwatch Barometer type PBR1.

[5] Cycling at extreme combinations of temperature, conductance and RH level may not always be possible.

Measuring units

Conductance: mmol m^{-2} s^{-1}, mm s^{-1}, cm s^{-1}
Resistance: s cm^{-1}, s m^{-1}, m^2 s mol^{-1}.

Calibration plate values at 20°C, 1000 hPa

Plate position	Conductance (mmol m^{-2} s^{-1})	Resistance (s cm^{-1})
1	15	27.3
2	25	16.5
3	55	7.4
4	132	3.1
5	257	1.6
6	513	0.8

Sensor head

Cups: (a) slot, 2.5 x 17.5 mm, rounded ends
(b) circle, 6 mm diameter
RH sensor: Vaisala 16663HM
Temp. sensors: high precision 100K thermistors
Light sensor: unfiltered GaAsP photodiode
Cable length: 1.2m
Size/weight: 110 x 30 x 27mm, 130g incl. Cable

Data handling

Reading memory: up to 1500 readings with full annotation (see sample printout)
Data interface: RS232 serial, up to 9600 baud, supplied with connector and adaptor for direct connection to PCs
Software: for Windows, saves data to a comma-separated ASCII data file (.CSV)

Control unit

Display: 8 lines x 40 character LCD
Keys: 13 function keys, plus full QWERTY keypad
Carrying case: padded with shoulder & waist straps.
Size/weight: 300 x 220 x 140mm, 3kg

Power Supply

Battery: internal rechargeable, 20 hour duration
Charger: separate unit, 12 to 15V DC, 0.5A, 110, 220 or 240V AC mains input (please state when ordering)
Recharge time: 14 hours

References

1. Monteith, J. L., Campbell, G. S. & Potter, E. A., 'Theory and performance of a dynamic diffusion porometer'. Agric. For. Meteorol. 44,27-38, 1988.
2. Stiles, W., Monteith, J. L. & Bull, T. A., 'A diffusive resistance porometer for field use'. J. Appl. Ecol.7,617-638,1970
3. Campbell, G. S., 'Steady-state diffusion porometers'. Research Bulletin 809, Washington State University,20-23,1975.
4. McDermitt, D. K., 'Sources of error in the estimation of stomatal conductance and transpiration from porometer data'. HortScience,25(12),1538-1548,1990.

Ordering Information

Porometer type AP4 including: built-in rechargeable battery, sensor head type PSH1, calibration plate, carrying bag, manual, quick guide, RS232 cable, data collection software, consumables kit type PCK1 (paper pads, tape, 500g silica gel, silica gel tube, 2 cup seals, cup gasket), battery charger (please specify mains 230 V AC 50Hz UK, or EURO, or 120V AC 60Hz).

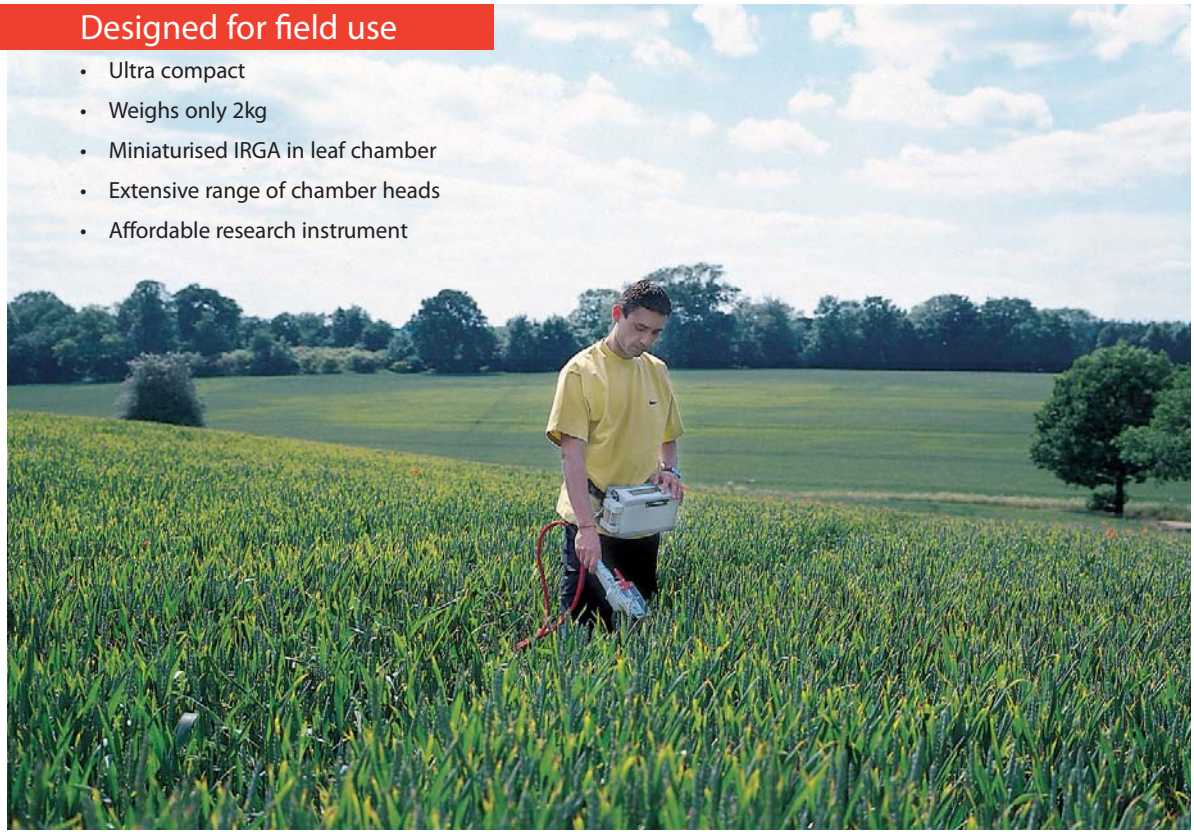
Optional items:
Wristwatch Barometer, **type PBR1**, reads atmospheric pressure.
AP4 consumables kit, **type PCK1**, complete set as included with instrument.
AP4 spares kit, **type PSK2**, includes spare manual. Detailed list available on request.
Spare AP4 sensor head, **type PSH1.**
Spare rechargeable battery, **type PSB2.**
Spare battery charger type **AP-CHG.**
Spare calibration plate **type AP-CP.**

LC i

The ultra compact photosynthesis system

Designed for field use

- Ultra compact
- Weighs only 2kg
- Miniaturised IRGA in leaf chamber
- Extensive range of chamber heads
- Affordable research instrument



Ultra compact and rugged

The LC i is our smallest, lightest and most user-friendly portable photosynthesis measurement system ever. It allows access to field sites previously considered unsuitable for conventional gas exchange systems.

Featuring ADC's renowned miniaturised infrared gas analyser, weighing just 2kg, the LC i is less than half the weight and size of most traditional systems. Full functionality, flow control and data logging are all contained within the ultra compact LC i console.

Powered by a single, small 12V rechargeable battery and incorporating the latest in low power consumption technology, the LC i will operate continuously for up to 10 hours from charging. In the field, the LC i is light enough to be carried using a shoulder strap or even worn on a belt.

The LC i is proving to be a valuable and reliable research tool in field programs throughout the world, maintaining optimal experimental performance even in the harshest of environments. Many scientific papers have already been published citing the LC i in their research.

ADC experience, innovation and quality

For over 35 years, ADC's name has been synonymous with photosynthesis measurements. Since the introduction of the first gas exchange systems, ADC has been at the forefront of instrument developments designed to meet ever-increasing research goals, using more user-friendly, portable and affordable equipment.

ADC is committed to quality:

Quality of product and quality of service.

From design to delivery, ensuring optimal performance and reliability is of paramount importance to our team of highly skilled and experienced engineers. Once in the field, you are supported by our network of over 40 customer support centres worldwide.

ADC BioScientific is an independent company, dedicated solely to the requirements and aspirations of plant science researchers.

The LC i is supplied, as standard, with a two year warranty.

Florida A&M University's graduate students Ms. Tresia Walters and Ms. Lelan Parker collecting data for photosynthetic activity of the "Blanc Du Bois" grapevine during "fruit set" with the LC i.

ADC BioScientific Ltd.

Technical Specification

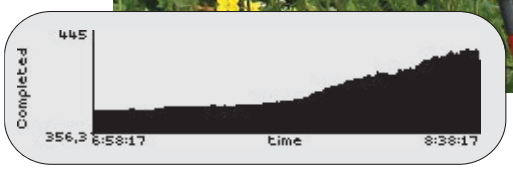
Measurement range and technique:	
CO_2:	0-2000ppm, 1ppm resolution. Infrared gas analysis, differential open system, auto zero, automatic atmospheric pressure and temperature compensation
H_2O:	0-75 mbar, 0.1mbar resolution Two laser-trimmed, fast response water vapour sensors
PAR:	0-3000µmols m^{-2} sec^{-1} Silicon photocell
Chamber temperature:	-5°C to 50 °C Precision thermistor +/- 0.2 °C accuracy
Direct leaf temperature:	-5°C to 50 °C Energy balance / Microchip thermistor
Gas exchange: Repeatability:	CO_2: 0.1% of reading @ 350ppm H_2O: 0.5% RH
Linearity	CO_2: 0.5% of reading H_2O: 1.0%
Temperature effect on span:	CO_2: <0.05% of f.s.d. per °C
Flow rate to leaf chamber:	100 to 500ml min^{-1}
Flow rate accuracy:	+/- 2% of f.s.d.
Display:	240 x 64 dot matrix super twist LCD
Warm up time:	5 minutes @ 20 °C
Recorded data:	Removable RAM cards typically store 16,000 sets of data on a 1Mb card
Battery:	2.8 Ah 12V lead acid battery. Life up to 10 hours
Battery charger:	Universal input voltage, intelligent control
RS232 output:	User-selectable rates of up to 19200 baud for printer or computer connection
Electrical connections: Power + analogue out:	5 Pin Din
RS232:	9 Pin "D" type
Leaf chamber:	15 Pin high density "D" type
Gas connections:	3mm barbed
Power requirements:	0.3A @ 12V DC
Operating temperature:	5°C to 45 °C
Dimensions H x W x D: Console:	240 x 125 x 140mm
Plant leaf chamber:	300 x 80 x 75mm
Weight: Console:	2.4kg
Plant leaf chamber:	0.6kg

HOSKIN SCIENTIFIC

LC pro+

The intelligent portable photosynthesis system

Unparalleled portability, uncompromised performance



- Fully programmable environmental control
- True field portability
- Miniaturised IRGA in leaf chamber
- Graphic display
- Unlimited data storage
- Powerful yet affordable

Introducing the first truly field portable and affordable gas exchange system with full environmental control.

Fully programmable environmental control

The LC pro+ provides full automatic and independent control of the environmental conditions within the plant leaf chamber. Utilising the latest microclimate management technology, automatic control of parameters is achieved both above and below ambient conditions.

The LC pro+ offers all the facilities and features required by the world's leading plant science researchers in the most portable format available.

CO_2 control:
Miniaturised integral CO_2 supply system

H_2O control:
On board conditioning chemicals

Temperature control:
Peltier heat transfer controller

PAR control:
Mixed red/blue LEDs

ADC: Never compromise on quality

Since the introduction of the first gas exchange systems, ADC has continued to be at the forefront of instrumentation developments. These are designed to make your research evermore sophisticated, using ADC's evermore user-friendly, portable and affordable equipment.

ADC is committed to Quality:

"quality of product and quality of service."

From design to delivery, ensuring optimal performance and reliability is of paramount importance to our team of experienced engineers. Once in the field, you are supported by our network of over 30 customer support centres worldwide.

As an independent company dedicated solely to the requirements and aspirations of plant science and environmental researchers, ADC BioScientific now introduces the future of sophisticated portable photosynthesis measurement instrumentation: the LC pro+.

ADC BioScientific Ltd.

Technical Specification

Measurement range and technique:	
CO_2:	0-2000ppm, optional 0-3000ppm,1ppm resolution. Infrared gas analysis, differential open system, auto zero, automatic atmospheric pressure and temperature compensation.
H_2O:	0-75mbar, 0.1mbar resolution. Two laser trimmed, fast response water vapour sensors.
PAR:	0-3000µmols m^{-2} sec^{-1} Silicon photocell. Cosine corrected.
Chamber temperature:	–5°C-50°C Precision thermistor.
Leaf temperature:	–5°C-50°C Self positioning microchip thermistor/Energy balance/manually positioned thermistor.
Flow rate to Plant Leaf Chamber:	100ml to 500ml min^{-1}
Automatic environmental control:	
Programming:	Internal LC pro+ menu driven software. Automatic and independent control of environmental conditions within the leaf chamber. For automatic response curves, sequential control levels and dwell times may be set.
CO_2:	Up to 2000ppm CO_2, by the integral elevated CO_2 supply system.
H_2O:	Above and below ambient (dependent on ambient conditions), by on-board self-indicating conditioning chemicals.
Temperature:	+ / - 10°C above and below ambient, by micro-peltier element.
PAR:	Up to 2000µmols m^{-2} sec^{-1}, (up to 1500µmols m^{-2} sec^{-1} for conifer) by high efficiency, low heat output, mixed red/ blue LED array unit.
Display:	240 x 64 dot matrix super twist LCD.
Recorded data:	Removable PC compatible cards storing unlimited data.
Battery:	7.0 Ah rechargeable lead acid battery. Life up to 16 hours. Battery charger: Universal input voltage, intelligent control.
RS232 output:	User-selectable rates of up to 57600 baud for printer or computer connection.
Analogue output:	Two channels. 0-5v user-selectable parameters.
Operating temperature:	5°C-45°C
Weight and Dimensions:	
Console:	4.4kg, 23 x 11 x 17cm
Plant Leaf Chamber:	0.8kg, 30 x 7 x 7 cm

HOSKIN SCIENTIFIC

Leaf Porometer model SC-1

- Automatic Sampling Mode Removes User Subjectivity
- No Daily Calibration
- No Tubes, Pumps, Fans, Moving Parts Or Heavy Equipment
- Accurate Steady-state Measurement
- Very Simple, Easy-to-use Interface
- Includes Software Utility For Downloading Data
- Low Cost "AA" Alkaline-battery Powered
- Non-destructive

The Leaf Porometer has an easy-to-use menu-driven interface, allowing you to use and manage your data. You can also add notes and comments to your saved data for later data analysis. The Leaf Porometer includes a user-friendly software utility for downloading data to your computer.

SPECIFICATIONS

Conductance range
0 to 500 mmol m^{-2} s^{-1}

Operating Environment
5 to 40 °C, 10 to 90% RH, non-condensing

Power
4 AA alkaline cells

Battery life
More than 1 year

Data storage
4095 measurements in flash memory

Interface
9 pin serial RS232 interface

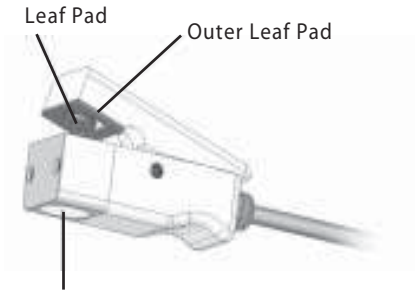
Measurement aperture
6.3 mm (0.25") diameter

Sensor head cable length
1.2m (4ft)

Manual and Auto Read mode options

Measurement time in Auto mode
30 seconds

Units
mmol $m^{-2}s^{-1}$, m^2s mol^{-1}, s/m



Applications
- Water use and water balance.
- Water stress measurements.
- Herbicide and pollutant uptake studies.
- Research on stomatal functions.
- Teaching and student labs.

■ Non-destructive sensor clip.

DECAGON DEVICES

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HOSKIN SCIENTIFIC

Hoskin Scientific Ltd

Micronutrient Plant Tissue Kits

Model Number: E-205-5026

Plant tissue testing provides essential information concerning plant use of nutrients vital to their growth. These simplified field tests for green plant tissue indicate whether growing plants are receiving adequate amounts of available nutrients from the soil. All tests give qualitative results for the specific nutrients. By comparing test results from healthy and problem plants, it is possible to pinpoint deficiencies or excessive nutrient conditions.

Model Number: Model: E-205-5261

Plant tissue testing provides essential information concerning plant use of nutrients vital to their growth. These simplified field tests for green plant tissue indicate whether growing plants are receiving adequate amounts of available nutrients from the soil. All tests give qualitative results for the specific nutrients. By comparing test results from healthy and problem plants, it is possible to pinpoint deficiencies or excessive nutrient conditions.
Includes tests for ferrous and ferric iron, zinc, copper, manganese, and boron. Each test is made from the sap of plant tissues, which is extracted by squeezing the tissue with pliers. Comparative tests are made between a healthy plant and a similar one showing deficiency symptoms. "Spot" tests indicate presence or absence only. Reagents for 50 tests each factor.

ADC BioScientific Ltd.

2 year warranty

AM300

Portable Leaf Area Meter

Non-destructive measurements of whole leaf area and areas of leaf disease

- Unique image display
- High resolution
- Battery portable
- Non-destructive
- Fast and simple operation
- Integral data and image storage
- Download image to a PC

ADC BioScientific is established as one of the world's leading developers and manufacturers of leaf area meters that are easy to use, accurate and reliable in harsh field conditions. We are now pleased to introduce our third generation of Portable Leaf Area Meters; the AM300.

The AM300 utilises the latest in scanner and electronics technology to set new standards in resolution, versatility and extended portability.

Truly field portable

The ADC AM300 Portable Leaf Area Meter is a compact, user-friendly, field portable instrument for the accurate non-destructive measurement of leaf area and associated parameters.

The AM300 consists of a high resolution scanner and scanboard with integral data and image storage. A multi-position carrying handle is provided for ease of use and increased portability. Measurements of leaves can be made on the scanboard plate or on an independent plain surface.

The AM300 features the latest in high speed scanner sensor technology, enabling measurements to be made faster and easier than ever. There is no need to precisely position leaves on the scan surface.

Utilising the latest in low power consumption electronics means that over 3,000 measurements can be made between recharging of the batteries.

Image download to a PC

The large scrolling display screen offers a real time image display of the scanned leaf together with measured leaf area parameters. By viewing this image, the user can be assured that an accurate and complete measurement of the leaf has been made. Measurements may be presented in mm, cm or inches.

The display orientation facility allows the AM300 to be used in either the vertical or horizontal plane. Operation is by user-friendly, menu driven software.

The AM300 is the first portable area meter that displays, stores and downloads the leaf image to a PC. Images are easily downloaded, in either bmp or tif formats, to commercially available image analysis programs.

HOSKIN SCIENTIFIC

Measurement of diseased leaf area

The highly versatile AM300 has been especially developed to enable diseased leaf area determinations to be made on intact plants in the field. Once again the image display provides the user with assurance that only the diseased tissue is being measured.

Long leaves are easily measured, non-destructively, on an independent scan surface. The image screen will scroll to display and save the whole of the leaf area.

Large leaves, which are wider than the width of the scanner, may also be measured, non-destructively, on an independent scan surface. The use of a scan board twice the width of the scanner will allow measurements to be made and then automatically accumulated to present a total leaf area with the leaf still intact.

The enhanced resolution (0.065mm ^{2}) of the AM300 allows even the smallest leaves, including arabidopsis, to be accurately measured. The AM300 can also be used for root and rhizomorph area determinations.

Integral data storage

Measurements, together with leaf images, may be automatically recorded on the large internal memory, capable of storing over 2,000 sets of data in a number of data files. Time and date of measurements are also automatically stored by the AM300.

The AM300 will measure area, accumulated area, average area, maximum width, maximum length and perimeter.

Internal battery back-up gives increased security to stored data.

Measurements and scanned images can be reviewed on the display, transferred to a printer or downloaded to a personal computer. The AM300 is supplied complete with an interface cable.

Technical Specification

Measured parameters:	Leaf area, length, width, perimeter, average area and accumulated area
Units of measurement:	User selectable: mm, cm, inches
Scanner:	Contact image sensor array with integral LED lamp
Maximum measurement width:	100mm
Precision/repeatability:	1% Linear, +/- 2% Area, +/- 5% Perimeter
Resolution:	0.065mm ^{2}
Memory:	256K bytes RAM, 2,000 data sets
Display:	64 x 240 pixel graphic LCD
Battery:	Nickel metal hydride 1.2Ah
Battery charger:	Built in fast charger; can use supplied mains adapter or 12V car battery. Indicators for charge status.
Computer interface:	RS232C with baud rates from 300 to 57600, xon/xoff or CTS handshake.
Printer interface:	Centronics™ parallel or RS232
Dimensions:	275mm x 250mm x 30mm
Weight:	1.8kg

Model 3000

The Plant Water Status Console, Model 3000, is supplied without the compressed gas cylinder or the pressure regulator, but does come with a 3-foot long, flexible, high pressure (3,000 psi working pressure) stainless steel connecting hose to connect to your pressure source. One end of the connecting hose is sealed to the pressure inlet of the console. The other end can be fitting with standard 1/4-inch pipe fittings to connect to your regulated pressure source. We recommend you use brass pipe and tube fittings that have a 3,000 psi working pressure. The regulated pressure that you supply to the console must not exceed the maximum pressure reading of the pressure readout gauge of the console. For standard units this pressure is 600 psi.

Model 3005 (Fig. 2)

The Plant Water Status Console, Model 3005, is supplied with a compressed gas cylinder and connected pressure regulator for field operation. The pressure regulator has been set at the factory for the maximum operating pressure of the unit which, for standard units, is 600 psi.

Generate soil moisture release characteristics

Measure water potential of soil samples for the root zone, seed zone, and under mulch.

Monitor water potential for bioremediation.

Measure water potential dependence of seed germination.

Monitor seed priming media.

Study plant-water relations

The WP4 is accurate and fast, and can be used with a variety of sample types.

WP 4-T Water Potential Measurement

Is temperature impacting your water potential results?

The WP4-T makes the difficult measurement of water potential easier. The WP4-T has a measurement range from 0 to -300 MPa and 3 to 6.5 pF (saturation to air dry) with an accuracy of 0.1MPa or better. The WP4-T senses the dewpoint of water vapor with a cooled mirror located above a sample in a closed chamber. Sample temperature is monitored with a built-in infrared thermometer, and the WP4-T's internal peltier cooler allows you to control the sample temperature from 15°C-40°C. Readings for individual samples are obtained rapidly (5-10 minutes for most soil samples).

Internal Temperature Control

Your lab temperature may vary as much as 5 degrees during the day. This results in as much as a -0.5 MPa difference in water potential readings on dry soil. Most researchers know that water potential changes with temperature. When you use the WP4-T you can measure the water potential of all your samples at a pre-set temperature. Temperature control allows you to monitor small changes in water potential from one sample to the next. By removing the temperature variables from your readings you more accurately measure water potential variations from sample to sample.

DECAGON DEVICES

HOSKIN SCIENTIFIC

SPECIFICATIONS

A ccuracy:
0 to -10 MPa (3 to 5 pF)± 0.lMPa
-10 to -300 MPa (5 to 6.5 pF) ± 1%

Range: 0 to -300 MPa
(3 to 6.5 pF)

Resolution: ± 0.01MPa.

M easurement Time:
5-10 minutes typical f or most soils, 15-20 minutes f or plant tissue

Operating environment:
5 to 43°C, 20 to 85% relative humidity.

Temperature control:
15°C to 40°C ± 0.2°C

W eight: 3.2 kilograms.

Shipping Weight: 5.2 kilograms

Case material: Powder coated aluminum.

Sample dish capacity:
15ml full (7ml r ecommended).

Enclosure size:
25.4 x 22.8 x 11.4cm

W arranty: 1 year.

Sensors: 1. Infrared sample surface temperatur e. 2. Cooled mirr or condensation dewpoint.

Po w er: 110V or 220V A C, 50/60Hz.

Communications: 9-pin D-subminiature, RS232A compatible, 8 data bit ASCII code, 9600 baud, no parity , 1 stop bit. Standar d RS232A serial cable included

Measuring water potential has never been so easy.

FEATURES:

* Durable laboratory-grade instrument with integral sensor draw er.

* Internal chilled-mirr or dewpoint measur ement is accurate ± 0.lMPa fr om 0 to -10MPa (3 to 5 pF), ± 1% from -10 to -300 MPa (5 to 6.5 pF).

* R5232A port allo wsdir ect data transfer to an attached computer.

* Disposable, lidded sample cups mak e sample handling easy .

* Single-point calibration; fast and simple

* Both w ater patential and sample temperature ar e display ed.

* Displays w ater potential in MPa & pF

* M enu-based user inter face with 10 selectable languages.

DECAGON DEVICES

HOSKIN SCIENTIFIC

Dualex® 4

SCIENTIFIC

FLAVONOLS & CHLOROPHYLL-METER

- REAL-TIME
- GEOLOCATED
- NON-DESTRUCTIVE
- ANY PLANTS & LEAVES
- MEASUREMENTS REGISTERED & CLASSIFIED

Force A

SEE TO ACT

HOSKIN SCIENTIFIC

DUALEX® SCIENTIFIC, AN INNOVATIVE TOOL

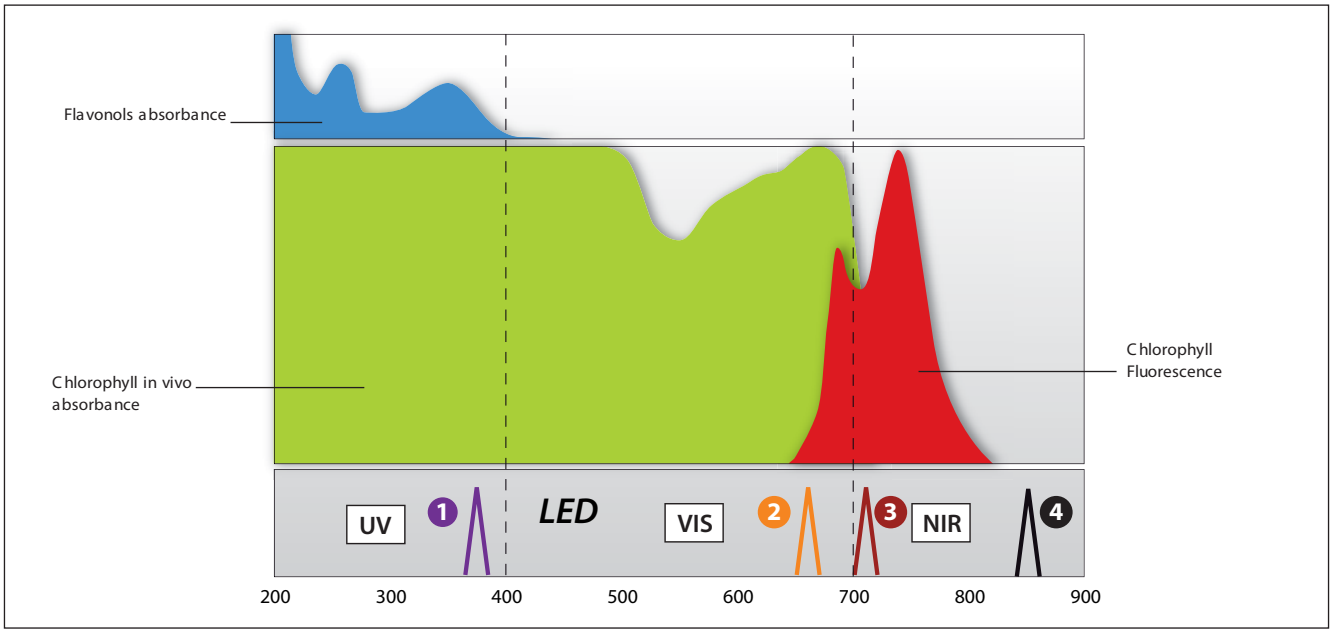
Resulting from a CNRS (National Center for Scientific Research) research team and the University of Paris Sud Orsay, this new leaf-clip can simultaneously and accurately monitor the chlorophyll- and flavonols-content from the leaf epidermis. Versatile, it is dedicated to plant science and agriculture. Used both on cereals, vine or perennials, this tool is simple to use. Measurements are instantaneous and non-destructive. They require no prior adjustment, and no sample preparation. Therefore, measurements can either be done in the laboratory or in the field, in all conditions of temperature and ambient light.

FLAVONOLS measurement

Flavonols have the property of being UV absorbers, and therefore to screen the chlorophyll absorption wavelengths within this spectrum. FORCE-A uses this role of natural UV filters to identify and quantify these molecules.

CHLOROPHYLL measurement

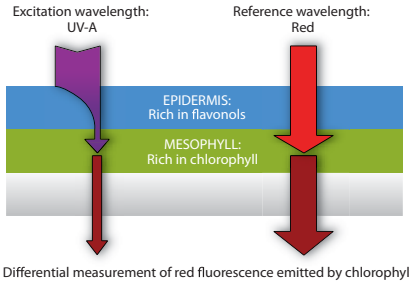
The optical properties of chlorophyll allow an accurate and rapid measurement by transmittance. A first wavelength very close to red ❸ quantifies the chlorophyll and a second in near infrared ❹ can take into account the effects of leaf structure.



A wavelength in the UV ❶ is compared to a second wavelength in the red ❷. Both wavelengths excite the fluorescence of chlorophyll, but only UV is affected by the presence of flavonols.

$$\text{Flavonols absorbance} = \text{Log}\ \frac{\text{Infrared Fluo. excited by Red}}{\text{Infrared Fluo. excited by UV}}$$

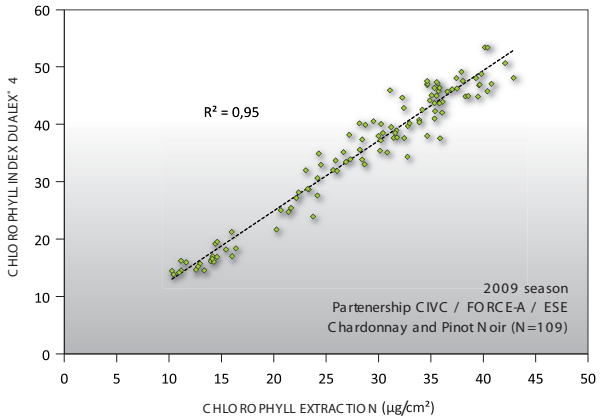
The difference in chlorophyll fluorescence measured in the infrared is thus directly proportional to the amount of flavonols present in the epidermis of the leaf.



Differential measurement of red fluorescence emitted by chlorophyll

By using these two wavelengths, the DUALEX® SCIENTIFIC calculates a numeric value directly correlated with chlorophyll content in the measured sample.

$$\text{Chlorophyll content} = \frac{\text{Infrared Trans.} - \text{Red Trans.}}{\text{Red Trans.}}$$



Strengths

- LIGHTWEIGHT AND PORTABLE
  Very light (only 220 g, battery included) and compact (it fits in the hand), DUALEX® SCIENTIFIC is easily transportable and can be used frequently. Its ergonomics is specifically designed to measure leaves over 16 cm wide.

- SIMPLE MEASUREMENTS
  In automatic mode, the measurement is recorded each time the device detects the presence of a leaf (can be deactivated).

- ADAPTED TO EXPERIMENTATION
  DUALEX® SCIENTIFIC offers the option to remove the last measurement, to manage measurements groups (two levels of classification), and to record more than 10.000 multiparametric measurements with information about date, time, group number and GPS positioning (meter accuracy).

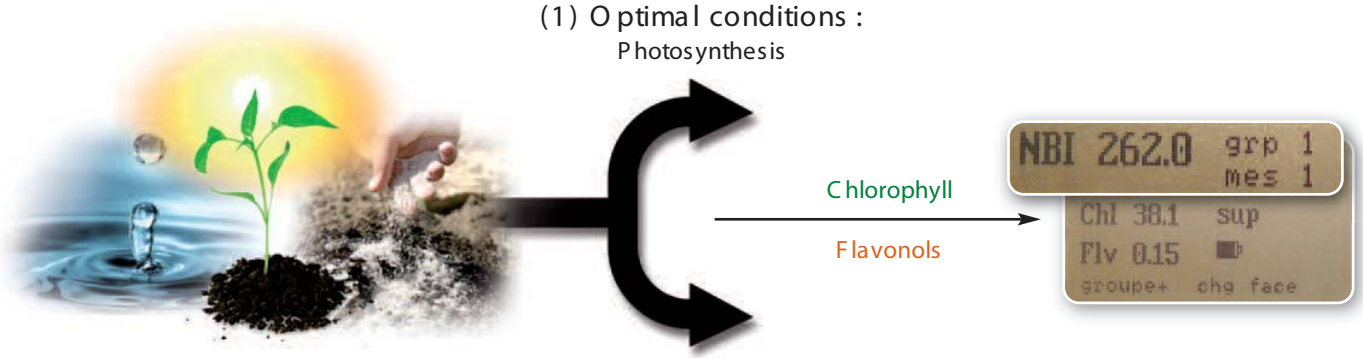
- EASY DATA MANAGEMENT
  Data can be downloaded via USB in a format compatible with any data processing software.

- LONG AUTONOMY
  Its rechargeable Li-ion high capacity battery is guaranteed for 1000 charging cycles. Thanks to the used technology, the device can achieve up to 25.000 measurements for a charging time of 4 hours maximum.

EXAMPLE OF APPLICATION : MONITORING OF NITROGEN STATUS A NEW INDEX, THE NBI®

Several years of research and experimentation showed that polyphenols, specifically flavonols, are indicators of nitrogen status of plants. Indeed, when a plant is in optimal conditions (1), it achieves its primary metabolism and synthesizes proteins (nitrogen-containing molecules) containing chlorophyll, and some flavonols (carbon chains). On the contrary, in case of nitrogen deficiency (2), it directs its metabolism towards the production of flavonols by the diagram below:

(1) Optimal conditions :
Photosynthesis



(2) Nitrogen deficiency:
Secondary metabolism

By using a new indicator called NBI® (Nitrogen Balance Index) which is the ratio Chlorophyll/ Flavonols (or Nitrogen/ Carbon), it is now possible to get an earlier information about the nitrogen status of cultures.

TECHNICAL SPECIFICATIONS - DUALEX® SCIENTIFIC

Measured material	Plant leaves
Measured parameters	Optical absorbance at a UV wavelength (flavonol content) Optical transmittance at 2 near-infrared wavelengths (chlorophyll content)
Measurement process	Main button pressure or clips closing (free choice)
Measured area	5 mm in diameter
Sample thickness	1 mm maximum
Measurement area access	8.5 cm maximum (half-leaf width)
Acquisition time	< 500 ms
Storage capacity	> 10 000 multiparametric measurements
Data classification	3 levels (file, group and measurement)
Flavonols rate	From 0.00 to 3.00 (Dualex® units, convertible to µg/ cm^2 after calibration)
Absorbance accuracy (σ)	5%
Repeatability (σ)	2.5%
Reproducibility (σ)	3.5%
Chlorophyll rate	From 0.00 to 150.00 (Dualex® units, convertible to µg/ cm^2 after calibration)
Repeatability (σ)	1.3%
Reproducibility (σ)	4.5%
NBI®	From 0.00 to 999.00 (ratio of Chlorophyll and Flavonol contents)
Temperature range	From 5 to 40°C (variation of absorbance < 2%)
Light sources	4 LED: 1 UV-A, 1 Red and 2 Near Infra-Red (NIR)
Detector	1 Silicon Photodiode
User interface	LCD screen Sound warning
Data downloading	USB connexion for transfer Data organisation compatible with any data processing software
Power source	Li-ion rechargeable battery
Autonomy	10 hours
Charging time	4 hours
Total weight	220 g (with battery)
Size	205 mm x 65 mm x 55 mm
Positioning	Internal GPS
Accuracy (pass to pass)	> 1 m
Languages	English, French
Safety	Incorporated ring for leash
Updating	Internet online updating

Warning: As FORCE-A is continuously improving its products, technical specifications can be changed without prior information.

Cartelat, A., Cerovic, Z.G., Goulas, Y., Meyer, S., Lelarge, C., Prioul, J.-L., Barbottin, A., Jeuffroy, M.-H., Gate, P., Agati, G., Moya, I., 2005. Optically assessed contents of leaf polyphenolics and chlorophyll as indicators of nitrogen deficiency in wheat (Triticum aestivum L.). Field Crops Res. 91, 35-49.
Cerovic, Z.G., Ounis, A., Cartelat, A., Latouche, G., Goulas, Y., Meyer, S., Moya, I., 2002. The use of, chlorophyll fluorescence excitation spectra for the nondestructive in situ assessment of UV–absorbing compounds in leaves. Plant Cell Environ. 25, 1663-1676.
Demotes-Mainard, S., Boumaza, R., Meyer, S., Cerovic, Z.G., 2008. Indicators of nitrogen status for ornamental woody plants based on optical measurements of leaf polyphenolics and chlorophyll contents. Sci. Hort. 115, 377-385.

Notice Dualex® 4 Scientific Anglaise - Edition 1 - Aout 2010 - Document non contractuel

Multiplex® 3

RESEARCH

UV-VISIBLE PORTABLE FLUORIMETER

- NON-DESTRUCTIVE / REAL-TIME
- GEOLOCATED MEASUREMENTS (GPS)
- LARGE SURFACE OF ANALYSIS (50 CM^2)
- MULTI-WAVELENGTHS (UV- VIS)
- REGISTERED & CLASSIFIED DATA
- ANY PLANT – LEAVES & FRUIT

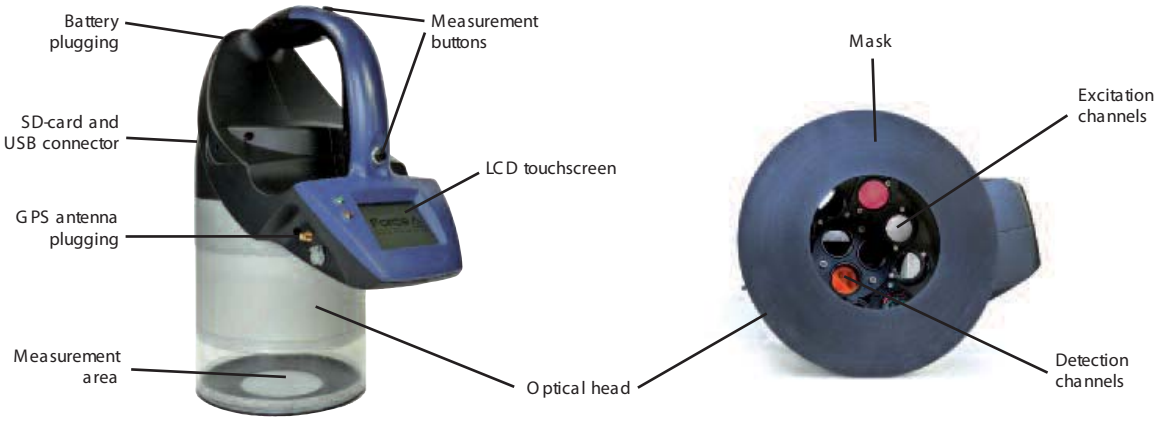
Force A
SEE TO ACT

HOSKIN SCIENTIFIC

TECHNICAL SPECIFICATIONS – MULTIPLEX® RESEARCH

Measured material	Any Plant Material: leaves, needles, berries, fruits, etc.
Measured parameters	Epidermal UV absorbency by FER method (flavonol content) Epidermal Visible absorbency by FER method (anthocyanin content) Chlorophyll fluorescence emission ratio (chlorophyll content) UV-excited Blue-Green Fluorescence (BGF_UV) Several other fluorescence ratios
Measurement process	Main button pressure
Distance	10 cm from measured material
Measured area	8 cm in diameter (4 or 6 cm optional)
Acquisition time	1 shot (250 acquisitions) < 1 s
Storage capacity	1 million multiparametric measurements (512 Mo SD-card)
Modes	One shot or continuous mode
Data classification	4 levels (file, group sample and measurement number)
Temperature range	From 5 to 45°C
Light sources	LED (pulsed operation) 4 excitation channels: UV, Blue, Green and Red
Detectors	Silicon Photodiodes 3 detection channels: Yellow (or Blue), Green and Red
User interface	3.2" graphic LCD panel with touchscreen Sound warning
Data downloading	SD-card / USB connection for data transfer in continuous mode Data organisation compatible with any data processing software
Power source	External Li-ion rechargeable battery
Autonomy	10 hours
Charging time	3 hours
Total weight	2.5 kg (without battery)
Optical head size	16 cm in diameter x 15 cm in height
Positioning	Internal GPS
Accuracy (pass to pass)	> 1 m
Language	English
Safety	Strap

Warning: As FORCE-A is continuously improving its products, technical specifications can be changed without prior information



FER method for flavonoid content, and fluorescence ratio for chlorophyll content: Cerovic Z.G., Ghozlen N.B., Milhade C., Obert M., Debuisson S. & Moigne M.L. (2015) Nondestructive diagnosis of grapevine nitrogen status using the Dualex. J. Agric. Food Chem. 63: 3669-3680; Cerovic Z.G., Masdoumier G., Ghozlen N.B. & Latouche G. (2012) A new optical leaf-clip meter for simultaneous non-destructive assessment of leaf chlorophyll and epidermal flavonoids. Physiologia Plantarum 146: 251-260; Goulas Y., Cerovic Z.G., Cartelat A. & Moya I. (2004) Dualex: a new instrument for field measurements of epidermal ultraviolet absorbance by chlorophyll fluorescence. Applied Optics 43: 4488-4496; Cerovic Z.G., Ounis A., Cartelat A., Latouche G., Goulas Y., Meyer S. & Moya I. (2002) The use of chlorophyll fluorescence excitation spectra for the non-destructive in situ assessment of UV-absorbing compounds in leaves. Plant, Cell and Environment 25: 1663-1676; Ounis A., Cerovic Z.G., Briantais J.-M. & Moya I. (2001) - Dual excitation FLIDAR for the estimation of epidermal UV absorption in leaves and canopies. Remote Sens. Environ. 76: 33-48; Gitelson, A.A., Buschmann, C. and Lichtenthaler, H.K. (1999) The chlorophyll fluorescence ratio F735/F700 as an accurate measurement of the chlorophyll content in plants. Remote Sensing of Environment 69: 296-302

FER method for anthocyanin content: Agati G., Pinelli P., Cortès Ebner S., Romani A., Cartelat A. & Cerovic Z.G. (2005) Nondestructive evaluation of anthocyanins in olive (Olea europaea) fruits by in situ chlorophyll fluorescence spectroscopy. J. Agric. Food Chem. 53: 1354-1363; Agati, G., Meyer, S., Matteini, P. & Cerovic, Z.G. (2007) Assessment of anthocyanins in grape (Vitis vinifera L.) berries using a non-invasive chlorophyll fluorescence method. J. Agric. Food Chem., 55: 1053-1061

UV-excited BGF: Cerovic, Z.G., Samson, G., Morales, F., Tremblay, N. & Moya, I. (1999) Ultraviolet-induced fluorescence for plant monitoring: present state and prospects. Agronomie: Agriculture and Environment, 19: 543-578; Meyer S., Cartelat A., Moya I. & Cerovic Z.G. (2003) UV-induced blue-green and far-red fluorescence along wheat leaves: a potential signature of leaf ageing. J. Exp. Bot., 54: 757-769

NBI® (Nitrogen Balance Index): Cartelat, A., Cerovic, Z.G., Goulas, Y., Meyer, S., Lelarge, C., Prioul, J.-L., Barbottin, A., Jeuffroy, M.-H., Gate, P., Agati, G. and Moya, I. (2005) Optically assessed contents of leaf polyphenolics and chlorophyll as indicators of nitrogen deficiency in wheat (Triticum aestivum L.). Field Crops Res., 91: 35-49.

Hoskin Scientific Ltd

Hand-Held Refractometers

This new type of Hand-held Refractometer is the first to be equipped with Automatic Temperature Compensation and Water Resistant (IP65) at the same time. While featuring functions such as Easy-to-Read, Easy-to-Hold, Smooth sampling, Easy disposal of sample from the edge, the improvement of hygiene aspect by employing the new type of grip, and well balanced structure, emphasis is also placed on its design, well exemplified by the streamlined body and the strong grip with rich texture.

*Verification with 10% Sucrose Solution (RE-110010), 20% Sucrose Solution (RE-110020) or 30% Sucrose Solution (RE-110030)

Hoskin Scientific Ltd

Pocket Refractometer

Application:
The PAL-1 is small and compact enough to fit in your pocket. Measurements can be made anywhere with ease.

- Outdoors at fruit and vegetable farming orchards
- Indoors at beverage and food factories
- At fruit and vegetable markets or supermarkets
- At restaurants or shops
- At junior high, high schools or universities as a course material

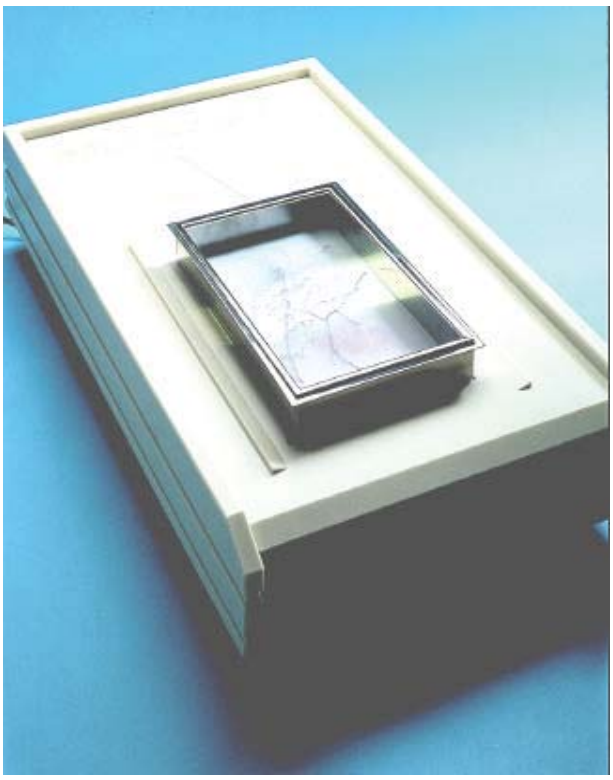
Specifications:

Measurement range.....Brix 0.0 to 53.0%
Resolution.....Brix 0.1%
Measurement Accuracy.....Brix +/- 0.2%
Measurement Temperature.....10 to 40°C (Automatic temperature compensation)
Power Supply.....2 x AAA Batteries
Waterproof Protection.....IP65
Dimensions and Weight.....55 x 31 x 109 mm, 100 g

Delta-T Scan
Root Analysis System

- **Fast, accurate root measurements**
- **High resolution over large area, no calibration needed**
- **Root length vs. diameter distribution analysis**
- **Soil particle size analysis**
- **Protected scanner, suitable for wet roots**
- **Root Washer option**

Delta-T Scan uses a customised flat-bed scanner to provide fast and easy analysis of roots, at high resolution



Powerful root analysis

Root measurements are of vital importance in plant science applications, but have often been neglected because of their difficulty. Using a specially splash protected flat-bed scanner, Delta-T Scan is optimised for high resolution root analyses, including:

- **root length, with a choice of three overlap correction methods**
- **root length, surface area and volume per unit volume of soil**
- **root length vs. diameter distributions**
- **root tip recognition, count and location**

Using Delta-T Scan

Prepared root samples are placed on the transparent trays supplied, using a special mesh panel to hold the roots flat against the base of the root tray. The sample is then scanned into an image file.

The scanner software includes a full range of functions for enhancing and thresholding the image of the sample. The image file is then passed to Delta-T Scan software, which provides a comprehensive range of analysis and measurement functions.

The analysis results are sent to output files which can be simply printed or listed on-screen, or may be exported to spreadsheets such as Excel, for further analysis and full graphical presentation of the data.

Delta-T Scan offers superior resolution over a much larger area than is possible with systems based on a video camera, and because the scanner delivers digitised images with a precise number of dots per mm, no specific calibration is required.

Comprehensive manuals supplied with Delta-T Scan explain every step from optimising images to presenting the results; they also cover much of the theory.

Other applications include:

- shape and size analysis of objects
- direct measurements from maps and photographs of a known scale
- counting of overlapping seeds
- soil particle size distributions
- sort by standard sieve mesh sizes
- leaf area measurements

A self-running demonstration disk is available.

Delta-T Scan Software Functions

Length analysis Analyses long, thin objects such as roots. Calculates the area, length, average diameter (thickness), and density in terms of length per unit volume. There are four alternative algorithms to choose from: Delta-T SCAN generic, after Kirchhof (1992); Newman/Head (1966); Harris/Campbell (1989); or user-defined.

Thickness (diameter) distributions Based on length analysis, this calculates the length in each of a range of diameter intervals, defined automatically, or by the user. For each interval an analysis of surface area and volume is given, along with averages, deviations and percentage of the whole sample, assuming the objects are tubular.

Tip count Counts the number of ends or tips in the image. Tip co-ordinates are recorded, permitting checks to be made on the accuracy of the count.

Object size Measures, classifies and provides statistical analysis of the sizes of all objects in the image, within intervals defined by the user, e.g. to correspond with standard sieve mesh sizes.

Object count Delta-T Scan provides a method of correcting for touching and overlapping objects that does not require user intervention. This avoids the need for manual image editing.

Object scan Measures area, width and perimeter length for all objects within the image, ranking them by area. The results can be filtered to record only those objects falling within defined limits.

Area analysis Calculates total area (black on white or white on black), and percentage of the whole image covered by the objects). Estimates total biomass by extrapolating from sub-sample data.

Point-and-shoot Measurement of linear distance, or area, width and perimeter of any discrete object, may be made by pointing with the mouse cursor and clicking.

Batch processing Useful for processing long runs of images or several large image files. A batch processing file is created, including the chosen settings and the analysis required for each image. Delta-T Scan then works on this file, producing results files automatically.

Delta-T Scan Specifications

PROTECTED FLAT-BED SCANNER
HP Scanjet with splash protection cover, vertical screen and power safety trip switch
Max resolution: 0.042mm (600 d.p.i. optical)
Max sample size: 297 x 216mm
Scan speed: 22s at 600 dpi
Interface: USB or SCSI port (NB: most scanners will require Windows 95 or later, a CD drive and 16Mb RAM)
Image editing: software included
Power: 100 -127V AC or 220-240V AC, 50/60 Hz, auto switching, 100 W maximum
Size/weight: 860 x 500 x 190 mm (incl. cover). Wt.11.0 kg

IMAGE ANALYSIS SOFTWARE
Image size and resolution limited only by scanner and computer memory.
Accuracy:
Root length: (with the Delta-T root length standard target set) Root length accuracy is critically dependent on good sample preparation, presentation, contrast and resolution. A set of precision, artificial root targets type CTS is available for validating the root length algorithms and calibration coefficients.
Area: <1% for optimised image quality, <5% typical (depends on resolution, contrast, sample thickness, etc.)
Image file formats: MSP, BMP, TIF, PCX
Computer requirements: Delta-T Scan is a DOS program and will run on most PC compatibles. See also Scanner Interface information, above.

ACCESSORIES
See price list for details of Root Preparation and Handling Kit Root Tray Set, Reference Target Sets and other accessories.

Root Washer

- **Semi-automatic operation**
- **Optional pump and tank**

Root washing is essential preparation for measuring and analysing root samples. Washing by hand is time consuming and labour intensive, often resulting in the loss of finer material.

The Delta-T Root Washer helps automate the task, and retains fine root filaments. Based on a design from CSIRO Cunningham Lab in Australia, the Root Washer consists of four buckets each with a central overflow pipe and two water jets in the base. The water swirls around and up, teasing roots and soil apart. Fine roots in the outflow are collected in a 500 micron mesh filter; those remaining in the bucket are poured through the filter. Depending on the soil type and sample volume, about 10 samples per hour can be washed.

Water mains supplies are usually at a lower pressure than the 38 litres per minute at 3500 hPa required for optimum washing performance. An electric pump and recirculation tank are available to ensure adequate pressure, and to conserve water.

Ordering information

Delta-T Scan: Complete systems including the protected flat-bed scanner, Delta-T Scan software, a computer and accessories can be supplied. All main items, spares and accessories are available separately.
Basic Root Washer System type RWB Requires a water supply of 38 litre/minute at 3500 hPa. Includes 4 buckets, each with 2 jets, table, sieves, spray gun, hoses and connectors, 5 m of 12.5 mm input hose, and 4 plastic pots to hold washed samples.
Pumped Root Washer System type RWC Includes all items in Basic System, plus recirculation tank and 0.55 kW electric pump with pressure gauge and safety cut-out. The tank, and pump are available separately. (Please note that 110V pumped Root Washer Systems are NOT available).

For details of options, accessories, spares, consumables and electrical requirements please contact Delta-T Devices

P1.32

PLANT ROOT SAMPLING

Root research is executed to improve the insight in the possibilities for root growth (depth and concentration) of the root system of trees and plants.
In general it is important to all plants to have a dense and extensive root system in the soil. An extensive root system allows the plant to benefit from a large volume of soil. If sufficient quantities of nutrients and water are present the absorption will be larger if the root system is more extensive.
Measuring the root system also is a useful means of localizing physical and/or chemical barriers in the soil profile.
If the root system researched deviates substantially from an 'ordinary' root system, then this is usually due to the following profile characteristics:

- ❒ Presence of layers that are hard to penetrate by roots, for example plough layers, bog ore, heavy clay and loam layers.
- ❒ Sharp contrast in profile, e.g. clay to sand, a soil rich of humus to a soil poor of humus (sand), etc.
- ❒ High groundwater level.
- ❒ Strongly fluctuating groundwater levels.
- ❒ Acidic layers.
- ❒ Poor oxygen content in the sub soil.

When comparing the root density of different soil samples, it is essential to compare samples of equal surface and contents.

05.01 Single root auger

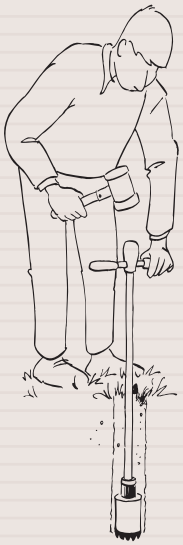
The single root auger is used to take undisturbed samples for root investigations in soils with low penetration resistance. Samples with a length of 15 cm can be taken to a depth of max. 1 m.

05.02 Bi-partite root auger, standard set for sampling to a depth of 2 m

By applying the bi-partite root auger almost undisturbed, uniform soil samples can be taken in layers of maximal 15 cm. The bi-partite root auger consists of a bottom part fitted with an exchangeable drilling-crown and a short unscrewable top part (handle) with a beating head.

The root auger is pushed into the soil from the surface by simply turning and pushing downward at the same time.

After reaming out the bore hole (to avoid the auger friction in the bore hole) the auger is hammered in the bottom of the bore hole applying an impact absorbing hammer.



Bi-partite root auger set

PLANT ROOT SAMPLING

P1.32

In lighter soil the auger can be pushed and turned into the soil. In heavier soils an impact absorbing hammer can be used.

In the standard set an Edelman- and a Riverside auger have been included for reaming out the bore hole and levelling the bottom (making it even). A conical threaded connection is used.

The root auger is fitted with a sample extruder unit which forces the soil sample from the cylinder of the auger. The extruder unit is operated by means of a crank handle.

The complete root auger set, including all accessories, is packaged in an aluminium transport case.

Advantages

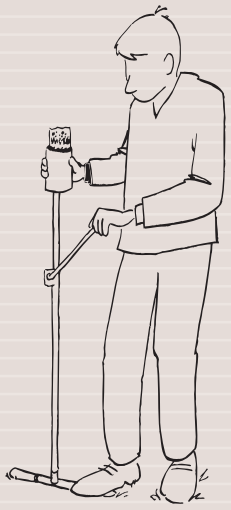
- In built-up areas minimal ground disturbance is needed; the re moval of one single paving stone is sufficient to take a sample.
- Almost completely undisturbed soil sampling.
- Because of the robust, heavy construction the root auger is also suitable for heavier soils.
- The samples taken are equal concerning surface and contents.
- Less disturbance (and faster operation) by comparison to digging a profile pit.

Applications

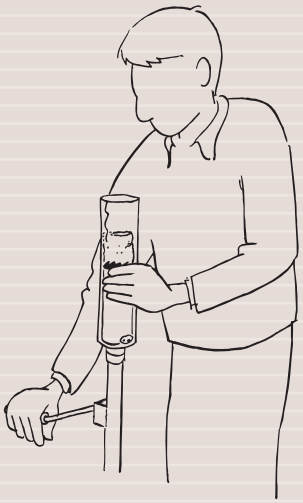
- Research to determine the possibilities to develop a root system and to determine the depth and the density of the root system.
- The root auger can be used in virtually all types of soil.
- Compound manure sampling.

By applying extension rods the auger can be used to a depth of approximately 2 meter.

The sample is pushed out of the auger by means of a handle.



The sample can be pressed into a collecting reservoir for transportation to the laboratory.



Bi-partite root auger

Drilling-crown, extruder in upper position

Drilling-crown, extruder in lower position

Eijkelkamp
Agrisearch Equipment
www.eijkelkamp.com

P1.32

PLANT ROOT SAMPLING

By alternatingly pushing one of both U-shaped gutters, the profile sampler cuts itself into the soil.

Once the required depth has been reached, the profile sampler is extracted from the soil in a clamped position.

05.08 Profile sampler

The profile sampler allows taking of a sizeable and virtually undisturbed sample up to a depth of approxi mately 40 cm (10 cm wide and 5 cm acr oss). All roots, up to a cross-section of 2 cm, are included in the sample.

When sampling, both U-shaped gutters are pushed alternatingly into the soil, until the required depth is reached, after which one side of the handle is pulled sharply upwards and the other pushed downwards, thus clamping the profile.
The profile sampler may now be extracted and opened to sample or describe the profile.
Also replacing the sample taken (in order to reduce the disturbance of the location to be researched to a minimum) is easily executed.

Advantages

- Compaction and integration of the various soil layers does not occur.
- Simple determination of the volume/weight of various differing layers.
- Sampling individual layers is no problem because the layers do not become disturbed.
- The observation of quantity and distribution of the root growth is both accurate and quick.
- A sizeable volume of the soil may be sampled, whereby the horizons of the samples are easily observed.
- Because sampling is efficiently executed it is possible to observe the fauna.

Applications

- Root growth research.
- Ecological/biological research of a strip layer in the forest.
- Soil surveying.
- Creating monoliths without the necessity of digging a profile pit.
- Suitable for almost all soils.

Profile sampler

Profile sample

PLANT ROOT SAMPLING

P1.32

05.09 Peat profile sampler, type Wardenaar

Until recently, sampling undisturbed peat profiles in peat lands, was a very difficult activity. Digging and sampling profile pits in most peat lands is difficult (if not impossible) as they would immediately fill with water and the walls would slump.

Researching the ecology of peat land environments and the dynamics and stratigraphy of peat profile requires undisturbed samples, especially of the top layers, where most biological activity takes place.

The peat profile sampler, type Wardenaar, is an apparatus for sampling intact, undisturbed peat profiles in peat lands up to a depth of 1 meter.

The peat profile sampler consists of a rectangular stainless steel box casing, divided lengthwise into two halves, with very sharp specially shaped cutting edges at the base.

The handgrip hinging with both halves allows both halves to be pushed into the soil alternatingly.

A clamp mechanism on the grip allows the profile to be clamped in the sampler when it is extracted from the soil. A small diameter tube is fitted to break the suction of the sample.

The standard set contains, among other items: the peat profile sampler, tools, lever beam with support and a hand pump.

Advantages

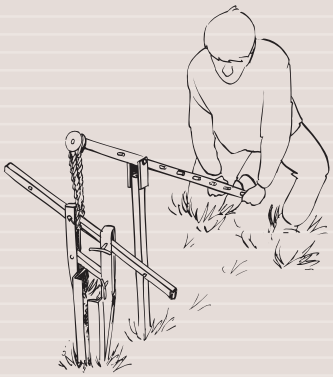
- One person is capable of extracting a 1 meter long profile in less then 10 minutes.
- Sizeable, undisturbed samples from (wet) peat lands are possible.
- After opening the profile can be sampled or researched immediately.

Applications

The profile is used for:

- Root growth studies.
- Pollen analysis.
- Macro-fossil studies (paleo-ecology).
- Creating soil monoliths.

The peat profile sampler is extracted from the soil by means of a lever and a support.



Peat profile sampler set

Peat profile

Peat profile sampler, type Wardenaar

Eijkelkamp
Agrisearch Equipment

www.eijkelkamp.com

HOSKIN SCIENTIFIC

Hoskin Scientific Ltd

Root Washer - RWB and RWC

The Delta-T Root Washer helps to automate the task of preparing roots for measurement and analysis. Washing by hand is laborious and often results in the loss of finer material. The Root Washer retains fine root filaments in a 500 micron mesh filter.

The Root Washer consists of 4 buckets, each with a water supply and a central overflow pipe, which holds the mesh filter. Two jets in the base of the bucket create an upward swirling flow that separates the roots from the soil. Depending on soil type, about 10 samples per hour can be washed.

Water mains pressure may be too low for optimal washing performance. The optional electric pump and recirculation tank ensure adequate pressure, with the further advantage of conserving water.

D6

Tree growth-sensor strain gage clip sensor

- Continuous high-resolution measuring of circumferential variation of trees
- Easy mounting without damage of the bark or disturbance of growth
- Measuring of daily changes and immediate reaction with an accuracy of 5 µm
- Minimisation of the cables friction on the bark and dependence on temperature
- Measuring range easily expandable by adjusting of the cable

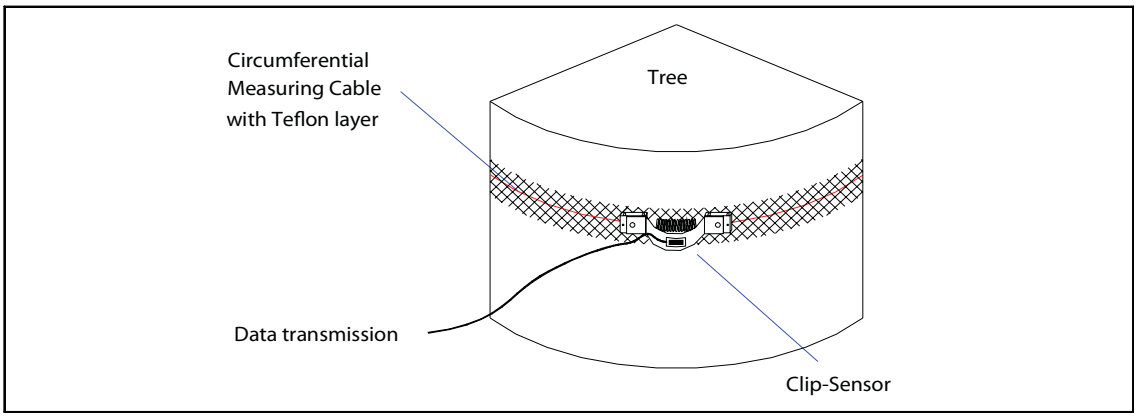


Fig 1: Principle of measurement

The Strain-Gage Clip-Sensoris designed for continuous high-resolution and automated measuring of circumferential variation of trees. Small in dimension and weight, the clip-sensor can easily be fixed on the trunk without any damage to the bark or disturbance of growth.
The complete sensor device is tightened like a belt and kept in position by a spring. Variations in tree dimensions are conducted directly to the sensor for recording the trees immediate reactions to environmental influences, swelling of the bark, level in water conduits or cell division.

Function: The trees dimensional changes are conveyed to the clip by a cable tied around the trunk and are transformed into a corresponding resistance change in strain gages, which are fixed on top and bottom of the clip, wired into a full Wheatstone bridge.
The cable's dependence on temperature is extremely low (1 ppm).
A special Teflon-layer is placed between cable and bark to reduce the friction of the cable and to protect it from icing, resin or callousing.

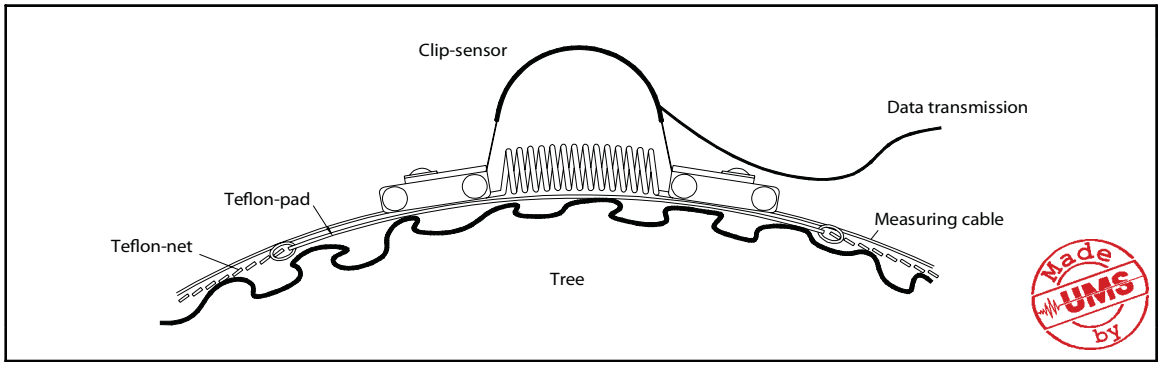


Fig. 2: Schematic view

The following diagrams show the results of measuringthe circumferential variations of a fir tree. The daily changes are registered very precisely. The trees reactions are explained by the daily weather conditions which were recorded simultaneously.

Fig. 3:
Circumferential variations* of a fir tree: Largest circumference at sun rise during dry period between Aug. 3rd and 6th; circumferential increase with rainfall starting on Aug 7.

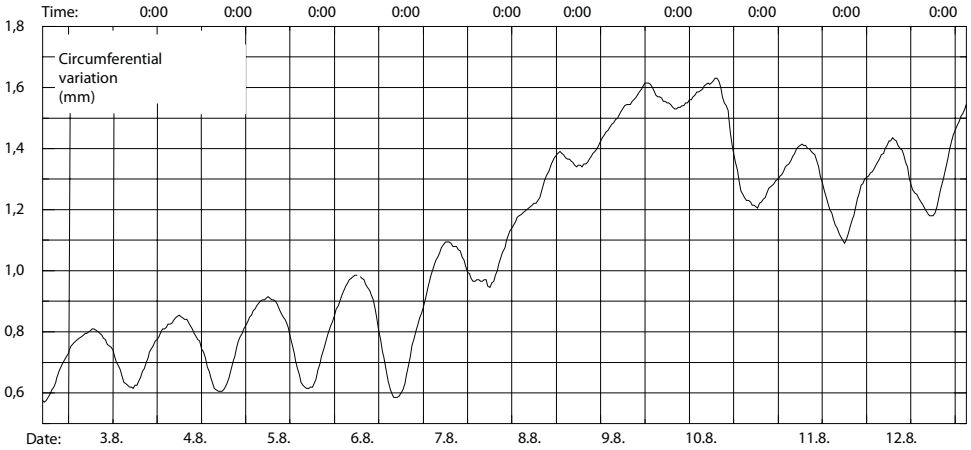
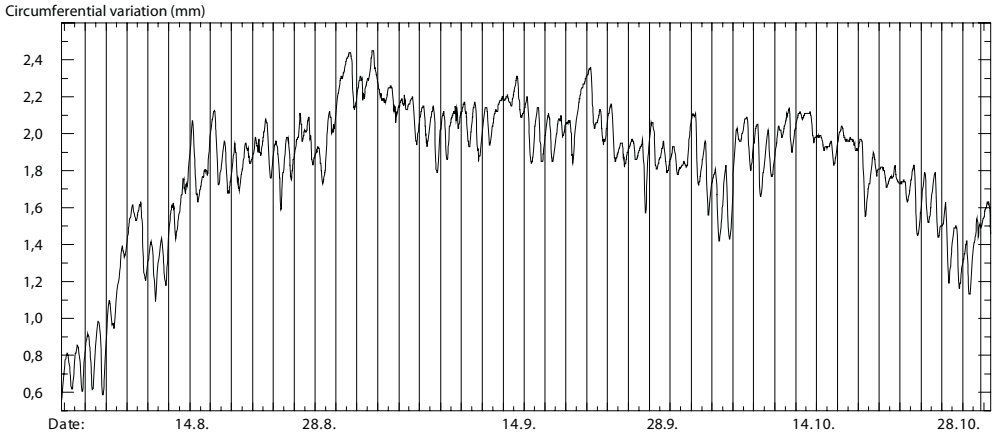


Fig.4:
Recording* of circumferential variation between August and October 1995.

(* Data acquisition every 30 minutes)



Technical Specifications

Art. No. D6

Sensor	4-wire full-bridge strain gages
Measuring range	50 mm circumf. growth without adjustment
Power supply	U_{DC} = 5...15 V $_{DC}$
Signal full-bridge	$U_{Sig} = U_{DC} * k * \varepsilon_{DMS} = U_{DC} * L * ü'$
Signal characteristic	$\Delta U_{Sig} / \Delta L$ = -0,12 mV/mm $* U_{DC}/V$
Range of signal	U_{Sig} » 9 mV ... 0.8 mV $* U_{DC}/V$

U_{DC}	Power supply voltage
U_{Sig}	Signal voltage
k	Strain gage value (k = 2,1)
ε_{DMS}	Strain gage tension
L	Distance between clip's ends
ΔL	Cirumferential variation
ü'	Clip's transforming value

Bridge-resistance	350 Ω	Weight	<20 g
Linearity	⊠1%	Embracing tension	<5 N
Accuracy	5 µm	Temperature range	-30°C ... +50°C
Max. current	50 mA	Dependence on temp.	<4 µm/K

The measuring cable is made of INVAR-steel, having an extremely low dependence on temperature (<1 µm/mK) and a very high resistance against corrosion. The strain-gages are covered with rubber polymer (IP67).

The clip-sensor can be used under atmospheric conditions (Rain, temperature -25 to +35°C). The full-bridge is temperature compensated.

Technische changes reserved ·Version August 2001
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D 1

Permanent Tree Girth Tape-measure

- Easy and quick installation
- Scale reading already shows diameter
- Vernier for accurate readings
- Minimised friction
- Low thermal expansion

The girth tape D1 was designed in co-operation with forest scientists for permanent manual readings of the diameter of trees through the circumference.

The scale division is 0,05 πcm and the vernier reading 0,01 πcm. The unit is π/1 [cm]. Therefore, the measured value already indicates the diameter of the trunk.

The installation is easy and quick. Lead the loose end of the tape-measure around the trunk and through the vernier. Then, hook in the spring to one of the eyelets with an initial spring expansion of min. 2 cm.

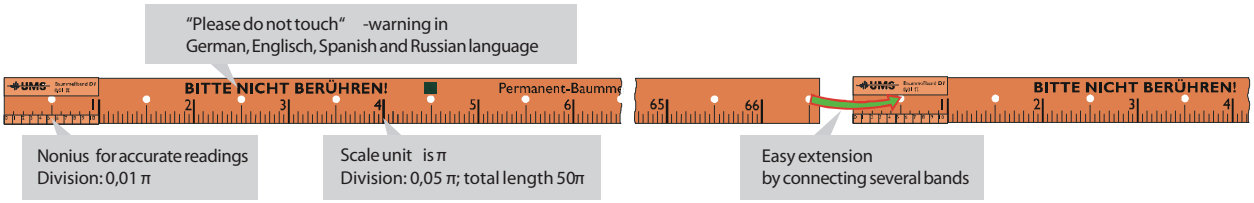
An exceptional feature of this girth tape is the minimised friction. There is only a printing on the top side to reduce the friction between the backside and the bark. The vernier is specially shaped for a frictionless guidance and the eyelets are manufactured without burr.

The girth tapes are made of Astralon, which has a thermal elongation of α = 75 x 10^{-6} K^{-1}. The accurate length is granted at 20°C. A shift of temperature will lengthen/shorten the band for only 0,075‰ per °C.

A single girth tape-measure is applicable for trunks with diameters from 10 to 66 cm. For larger trunks two tapes can easily be connected. Use the short spring for diameters below 40 cm.

The warning "Please do not touch" is printed on in German, English, Spanish, Chinese and Russian language.

Type (spring size)	- K	- L
Length, unexpanded	75 mm	150 mm
Max. allowed expansion	18 cm	36 cm
For trunks with diameter	< ⌀ 40 cm	> ⌀ 40 cm



Technical Specifications

Length	2100 mm
Width	15 mm
Thickness	0,5 mm
Thermal elongation	75 x 10^{-6} / K
Tensile strength	64 N/mm²
Coefficient of friction	0,5 on dry bark
Working temperature	-30 °C ... + 60 °C
Colour of tape / print	brown / black
Weight of band	16 g
Weight of spring	7 g (-K); 14 g (-L)
Max. tension at max. allowed expansion	6 N

Specification	Type
Girth tape-measure with short spring	**D1-K**
Girth tape-measure with long spring	**D1-L**

Hoskin Scientific Limited has been supplying testing and monitoring instruments since 1946. Although our range is broad, we focus on three major markets including:

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Environmental Monitoring
Test & Measurement Instrumentation

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